# NARAYANA ENGINEERING COLLEGE::GUDUR

AUTONOMOUS

DEPARTMENT OF ELECTRICAL AND ELETRONICS ENGINEERING

Course Structure for B.Tech E.E.E w.e.f AY: 2021-22

SEMESTER I

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21MA1001 | BS | Algebra and Calculus | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 |
| 21PH1001 | BS | Applied Physics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1003 | ES | Basic Electrical Circuits | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1001 | ES | Problem Solving and Programming | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21PH1501 | BS | Applied Physics Lab | **0** | **0** | **3** | **3** | **1.5** | 40 | 60 | 100 |
| 21ES1506 | ES | Basic Electrical Circuits Lab | 0 | 0 | **2** | **2** | **1** | 40 | 60 | 100 |
| 21ES1505 | ES | Engineering and IT Workshop | 0 | 0 | **3** | **3** | **1.5** | 40 | 60 | 100 |
| 21ES1501 | ES | Problem Solving and Programming Lab | **0** | **0** | **3** | **3** | **1.5** | 40 | 60 | 100 |
| 21EN1502 | **HS** | Communication skills lab | **0** | **0** | **2** | **2** | **1** | 40 | 60 | 100 |
| **21MC8001** | **MC** | Mandatory course I :Induction Program | Induction Program | | | | | | | |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | Total | **12** | **1** | **16** | **29** | **19.5** | **360** | **540** | **900** |

SEMESTER II

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21CH1001 | BS | Chemistry | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21MA1003 | BS | Vector Calculus Complex Variables and Transforms | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 |
| 21ES1005 | ES | Python Programming and Data Science | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EN1001 | HS | English | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21CH1501 | BS | Chemistry Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21ES1503 | ES | Engineering Graphics | 0 | 1 | 4 | 5 | 3 | 40 | 60 | 100 |
| 21ES1508 | ES | Python Programming and Data Science Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EN1501 | HS | English Language Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | Total | **11** | **2** | **16** | **29** | **19.5** | **320** | **480** | **800** |

SEMESTER III

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21MA1006 | BS | Probability Statistics and Numerical Methods | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1009 | ES | Data Structures and Algorithms | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1010 | ES | Electronic Devices and Circuits | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2001 | PC | DC Machines and Transformers | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2002 | PC | Electrical Circuit Analysis | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2003 | PC | Power System Architecture | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1513 | ES | Data Structures and Algorithms Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21ES1514 | ES | Electronics Devices and Circuits Lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CD6001 | SC | Career competency Development I | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CC6001 | SC | Value added course/Certificate course I | 0 | 0 | 0 | 0 | 1 | 40 | 60 | 100 |
| 21MC8002-13 | MC | Mandatory course II | 2 | 0 | 0 | 2 | 0 | -- | -- | -- |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **19** | **0** | **10** | **29** | **21.5** | **400** | **600** | **1000** |

SEMESTER IV

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EN1002 | HS | Universal Human Values | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2004 | PC | AC Machines | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2005 | PC | Analog Electronic Circuits | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2006 | PC | Engineering Electromagnetics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2007 | PC | Linear Control Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open elective I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2501 | PC | DC Machines and Transformers Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2502 | PC | Electrical Circuits and Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2503 | PC | Linear Control Systems and Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21CD6002 | SC | Career competency Development II | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21IC6001 | SC | Industry Oriented Course I | 0 | 0 | 0 | 0 | 1 | 100 | -- | 100 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **18** | **0** | **14** | **32** | **24.5** | **500** | **600** | **1100** |

SEMESTER V

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EE2008 | PC | Digital Electronics and logic design | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2009 | PC | Power Distribution and Distributed Generation | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2010 | PC | Power Electronics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open elective II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE4001-05 | PE | Professional Elective I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2504 | PC | AC Machines Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2505 | PC | Analog Electronics and Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2506 | PC | Power Electronics and Simulation Lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CD6003 | SC | Career competency Development III | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CC6002 | SC | Value added course/Certificate Course II | 0 | 0 | 0 | 0 | 1 | 40 | 60 | 100 |
| 21EE7501 | PR | Internship/skill development Training I | 0 | 0 | 0 | 0 | 1.5 | 00 | 100 | 100 |
| 21MC8002-13 | MC | Mandatory course III | 2 | 0 | 0 | 2 | 0 | 00 | 00 | 00 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **16** | **0** | **13** | **29** | **21.5** | **400** | **700** | **1100** |

SEMESTER VI

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EE2011 | PC | Advanced Power System Analysis | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2012 | PC | Electrical Measurements and Instrumentation | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2013 | PC | Switch Gear and Protection | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open Elective III | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE4006-10 | PE | Professional Elective II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE40011-15 | PE | Professional elective III | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2507 | PC | Electrical Measurements and Instrumentation Lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21EE2508 | PC | Power Systems Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21CD6004 | SC | Career competency Development IV | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21IC6002 | SC | Industry Oriented Course II | 0 | 0 | 0 | 0 | 1 | 100 | -- | 100 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **17** | **0** | **10** | **27** | **21.5** | **460** | **540** | **1000** |

SEMESTER VII

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EN5001-5 | HS | Humanities and Social Science Elective | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2014 | PC | Solid State Electric Drives | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2015 | PC | Power System Operation and Control | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open Elective IV | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE40016-20 | PE | Professional elective IV | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE40021-25 | PE | Professional elective V | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2509 | PC | Electronic systems design lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21EE2510 | PC | Power Systems Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21CD6005 | SC | Career competency Development V | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CC6501 | SC | Skill development Training | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21EE7502 | PR | Internship II/on job training/Com Ser Project | 0 | 0 | 0 | 0 | 1.5 | 00 | 100 | 100 |
| 21MC8002-13 | MC | Mandatory course IV | 2 | 0 | 0 | 2 | 0 | -- | -- | -- |
| | | Counseling/Mentori | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **19** | **0** | **12** | **31** | **23** | **400** | **700** | **1100** |

SEMESTER VIII

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EE7503 | PR | Project work, seminar and internship | 0 | 0 | 0 | 0 | 12 | 60 | 140 | 200 |
| | | | **0** | **0** | **0** | **0** | **12** | **60** | **140** | **200** |

OPEN ELECTIVES (OE) Offered by EEE Department

| Department | Course Code | Open Elective |
|---|---|---|
| **Electrical and Electronics Engineering** | 21EE3001 | Artificial Neural Networks and Fuzzy Logic |
| | 21EE3002 | Basic Electrical and Electronics Engineering |
| | 21EE3003 | Energy Audit and Demand side Management |
| | 21EE3004 | Electrical Measurements and Instrumentation |
| | 21EE3005 | Utilization of Electrical Energy |
| | 21EE3006 | Industrial Automation Engineering |
| | 21EE3007 | Industrial Electrical Systems |
| | 21EE3008 | Renewable Energy Conversion Systems |
| | 21EE3009 | Power Quality |

PROFESSIONAL ELECTIVES (PE)

| Elective Track/Group | Professional Elective-1 | Professional Elective-2 | Professional Elective-3 | Professional Elective-4 | Professional Elective-5 |
|---|---|---|---|---|---|
| Advanced Power systems | Industrial Electrical Systems (21EE4001) | Power System Planning (21EE4006) | Reactive Power Compensation and Management (21EE4011) | Power Quality (21EE4016) | Smart Grid Technologies (21EE4021) |
| Control Systems | System Modeling and Identification (21EE4002) | Advanced Control systems (21EE4007) | Digital Signal Processing (21EE4012) | Multivariable Control System (21EE4017) | Real Time Control System (21EE4022) |
| Electromechanical Systems | Machine Modeling and Analysis (21EE4003) | Electrical Machine Design (21EE4008) | Programmable Control Devices and Applications (21EE4013) | Hybrid Electrical Vehicles (21EE4018) | Automotive Electrical Engineering (21EE4023) |
| Energy Systems | Renewable Energy Conversion Systems (21EE4004) | Solar and Fuel Cell Energy Systems (21EE4009) | Wind and Biomass Energy Systems (21EE4014) | Utilization of Electrical Energy (21EE4019) | Energy Audit and Demand side Management (21EE4024) |
| Power Electronics | Advanced Power Electronics (21EE4005) | Advanced Electrical Drives (21EE4010) | HVDC and FACTS (21EE4015) | Advanced Power Converters (21EE4020) | Advanced Power Semiconductor Devices and Protection (21EE4025) |

LIST OF HONOR SUBJECTS

| S.NO | Course code | Course Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | 21EEH001 | Adaptive Control Systems | 3-1-0 | 4 |
| 2 | 21EEH002 | AC Drives | 3-1-0 | 4 |
| 3 | 21EEH003 | Advanced Power System Protection | 3-1-0 | 4 |
| 4 | 21EEH004 | Power System Wide area Monitoring and Control | 3-1-0 | 4 |
| 5 | 21EEH005 | Restructed Power Systems | 3-1-0 | 4 |

# LIST OF MINOR SUBJECTS

| S.NO. | Course code | Course Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | 21EEM001 | Electrical Technology | 3-1-0 | 4 |
| 2 | 21EEM002 | Electrical Measurements and Instrumentation | 3-1-0 | 4 |
| 3 | 21EEM003 | Power System Architecture | 3-1-0 | 4 |
| 4 | 21EEM004 | Utilization of Electrical Energy | 3-1-0 | 4 |
| 5 | 21EEM005 | Linear Control Systems | 3-1-0 | 4 |

Humanities and Social Science Elective

| S. NO | Course code | Course Name | CREDITS |
|---|---|---|---|
| 1 | 21EN1001 | Managerial Economics & Financial Analysis | 3 |
| 2 | 21EN1002 | Management Science | 3 |
| 3 | 21EN1003 | E-Business | 3 |
| 4 | 21EN1004 | Organizational Behavior | 3 |
| 5 | 21EN1005 | Enterprise Resource Planning | 3 |

PROFESSIONAL ELECTIVES (PE)

| SEMESTER | Course code | SUBJECT | CREDITS |
|---|---|---|---|
| **V Sem** | 21EE4001-05 | Professional Elective I | 3 |
| **VI Sem** | 21EE4006-10 | Professional Elective II | 3 |
| | 21EE4011-15 | Professional Elective III | 3 |
| **VII Sem** | 21EE4016-20 | Professional Elective IV | 3 |
| | 21EE4021-25 | Professional Elective V | 3 |
| | | **TOTAL** | **15** |

OPEN ELECTIVES (OE)

| SEMESTER | SUBJECT | CREDITS |
|---|---|---|
| **IV Sem** | Open Elective I | 3 |
| **V Sem** | Open Elective II | 3 |
| **VI Sem** | Open Elective III | 3 |
| **VII Sem** | Open Elective IV | 3 |
| | **TOTAL** | **12** |

SKILL ORIENTED COURSE (SC)

| SEMESTER | Course code | SUBJECT | CREDITS |
|---|---|---|---|
| III Sem | 21CD6001 | Career Competency Development I | 1 |
| | 21CC6001 | Value Added Course/Certificate Course I | 1 |
| IV Sem | 21CD6002 | Career Competency Development II | 1 |
| | 21CC6001 | Industry Oriented Course I | 1 |
| V Sem | 21CD6003 | Career Competency Development III | 1 |
| | 21CC6002 | Value Added Course/Certificate Course II | 1 |
| VI Sem | 21CD6004 | Career Competency Development IV | 1 |
| | 21CC6002 | Industry Oriented Course II | 1 |
| VII Sem | 21CD6005 | Career Competency Development V | 1 |
| | 21CC6501 | Skill Development Training | 1 |
| | | TOTAL | **10** |

PROJECT (PR)

| SEMESTER | Course code | SUBJECT | CREDITS |
|---|---|---|---|
| **V Sem** | 21EE7501 | Internship I/on job training/Com Ser Project | 1.5 |
| **VII Sem** | 21EE7502 | Internship II/on job training/Com Ser Project | 1.5 |
| **VIII Sem** | 21EE7503 | Project work, seminar and internship | 12 |
| | | **TOTAL** | **15** |

## HUMANITIES AND SOCIAL SCIENCES (HS)

| SEMESTER | Course code | SUBJECT | CREDITS |
|---|---|---|---|
| I | 21EN1502 | Communication skills lab | 1 |
| II | 21EN1001 | English | 2 |
| | 21EN1501 | English Language Lab | 1.5 |
| IV | 21EN1002 | Universal Human Values | 3 |
| VII | 21EN5001-8 | Humanities and social Science Elective | 2 |
| | | **TOTAL** | **9.5** |

## BASIC SCIENCES (BS)

| SEMESTER | Course code | SUBJECT | CREDITS |
|---|---|---|---|
| I | 21MA1001 | Algebra and Calculus | 4 |
| | 21PH1001 | Applied Physics | 3 |
| | 21PH1501 | Applied Physics Lab | 1.5 |
| II | 21CH1001 | Chemistry | 3 |
| | 21MA1003 | Vector Calculus, Complex Variables and Transforms | 4 |
| | 21CH1501 | Chemistry lab | 1.5 |
| III | 21MA1006 | Probability Statistics and Numerical Methods | 3 |
| | | **TOTAL** | **20** |

## ENGINEERING SCIENCES (ES)

| SEMESTER | Course code | SUBJECT | CREDITS |
|---|---|---|---|
| I | 21ES1003 | Basic Electrical Circuits | 3 |
| | 21ES1001 | Problem Solving and Programming | 3 |
| | 21ES1506 | Basic Electrical Circuits Lab | 1 |
| | 21ES1505 | Engineering and IT Workshop | 1.5 |
| | 21ES1501 | Problem Solving and Programming Lab | 1.5 |
| II | 21ES1005 | Python Programming and Data Science | 3 |
| | 21ES1503 | Engineering Graphics | 3 |
| | 21ES1508 | Python Programming and Data Science Lab | 1.5 |
| III | 21ES1009 | Data Structures and Algorithms | 3 |
| | 21ES1010 | Electronic Devices and Circuits | 3 |
| | 21ES1513 | Data Structures and Algorithms Lab | 1.5 |
| | 21ES1514 | Electronics Devices and Circuits Lab | 1 |
| | | **Total** | **26** |

## PROFESSIONAL CORE (PC)

| SEMESTER | | SUBJECT | CREDITS |
|---|---|---|---|
| III | 21EE2001 | DC Machines and Transformers | 3 |
| | 21EE2002 | Electrical Circuit Analysis | 2 |
| | 21EE2003 | Power System Architecture | 3 |
| | | 8 | |
| IV | 21EE2004 | AC Machines | 3 |
| | 21EE2005 | Analog Electronic Circuits | 3 |
| | 21EE2006 | Engineering Electromagnetics | 3 |
| | 21EE2007 | Linear Control Systems | 3 |
| | 21EE2501 | DC Machines and Transformers Lab | 1.5 |
| | 21EE2502 | Electrical Circuits and Simulation Lab | 1.5 |
| | 21EE2503 | Linear Control Systems and Simulation Lab | 1.5 |
| | | 16.5 | |
| V | 21EE2008 | Digital Electronics and logic design | 2 |
| | 21EE2009 | Power Distribution and Distributed Generation | 3 |
| | 21EE2010 | Power Electronics | 3 |
| | 21EE2504 | AC Machines Lab | 1.5 |
| | 21EE2505 | Analog Electronics and Simulation Lab | 1.5 |
| | 21EE2506 | Power Electronics and Simulation Lab | 1 |
| | | 12 | |
| VI | 21EE2011 | Advanced Power System Analysis | 3 |
| | 21EE2012 | Electrical Measurements and Instrumentation | 2 |
| | 21EE2013 | Switch Gear and Protection | 3 |
| | 21EE2507 | Electrical Measurements and Instrumentation Lab | 1 |
| | 21EE2508 | Power Systems Lab | 1.5 |
| | | 10.5 | |
| VII | 21EE2014 | Solid State Electric Drives | 3 |
| | 21EE2015 | Power System Operation and Control | 3 |
| | 21EE2509 | Electronic systems design lab | 1 |
| | 21EE2510 | Power Systems Simulation Lab | 1.5 |
| | | 8.5 | |
| | | TOTAL | **55.5** |

# Overall Credits

| S. NO | CATEGORY | CREDITS PER SEMESTER | | | | | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | |
| 1 | HS | 1 | 3.5 | | 3 | | | 2 | | **9.5** |
| 2 | BS | 8.5 | 8.5 | 3 | | | | | | **20** |
| 3 | ES | 10 | 7.5 | 8.5 | | | | | | **26** |
| 4 | PC | | | 8 | 16.5 | 12 | 10.5 | 8.5 | | **55.5** |
| 5 | PE | | | | | 3 | 6 | 6 | | **15** |
| 6 | OE | | | | 3 | 3 | 3 | 3 | | **12** |
| 7 | SC | | | 2 | 2 | 2 | 2 | 2 | | **10** |
| 8 | PR | | | | | 1.5 | | 1.5 | 12 | **15** |
| | **TOTAL** | **19.5** | **19.5** | **21.5** | **24.5** | **21.5** | **21.5** | **23** | **12** | **163** |

SEMESTER I

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21MA1001 | BS | Algebra and Calculus | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 |
| 21PH1001 | BS | Applied Physics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1003 | ES | Basic Electrical Circuits | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1001 | ES | Problem Solving and Programming | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21PH1501 | BS | Applied Physics Lab | **0** | **0** | **3** | **3** | **1.5** | 40 | 60 | 100 |
| 21ES1506 | ES | Basic Electrical Circuits Lab | 0 | 0 | **2** | **2** | **1** | 40 | 60 | 100 |
| 21ES1505 | ES | Engineering and IT Workshop | 0 | 0 | **3** | **3** | **1.5** | 40 | 60 | 100 |
| 21ES1501 | ES | Problem Solving and Programming Lab | **0** | **0** | **3** | **3** | **1.5** | 40 | 60 | 100 |
| 21EN1502 | **HS** | Communication skills lab | **0** | **0** | **2** | **2** | **1** | 40 | 60 | 100 |
| **21MC8001** | **MC** | Mandatory course I :Induction Program | Induction Program | | | | | | | |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | Total | **12** | **1** | **16** | **29** | **19.5** | **360** | **540** | **900** |

| NARAYANA ENGINEERING COLLEGE: GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B. Tech | ALGEBRA AND CALCULUS (21MA1001) | | | | | | | R-2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 1 | 0 | 64 | 4 | 40 | 60 | 100 |

**Pre-requisite**: Intermediate Mathematics

**Course Objectives:**

1. To familiarize the students with the theory of matrices and quadratic forms.
2. To analyze second order ordinary differential equations.
3. To explain the series expansions using mean value theorems and the concepts of multivariable calculus.
4. To summarize the procedure to solve the partial differential equations.
5. To explain the student with mathematical tools needed in evaluating multiple integrals and its applications.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | **Make use** the concepts of Matrices **to solve various Engineering problems.** **(BL-3)** |
| **CO 2** | **Identify** different types of higher order differential equations and their applications **in solving engineering problems.** **(BL-3)** |
| **CO 3** | **Apply** Mean value theorems, Multi variable calculus **to solve engineering problems.** **(BL-3)** |
| **CO 4** | **Apply** a range of techniques **for solutions of first order Linear and non-Linear Partial Differential Equations (PDE).** **(BL-3)** |
| **CO 5** | **Apply** the techniques of multiple integrals **for the area and volume of the region bounded by curves.** **(BL-3)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | | | | | | | | | | | | |
| CO2 | 3 | 3 | | | | | | | | | | | | |
| CO3 | 3 | 3 | | | | | | | | | | | | |
| CO4 | 3 | 3 | | | | | | | | | | | | |
| CO5 | 3 | 3 | | | | | | | | | | | | |

1- Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Matrices | Hours: 16h(12L+4T) |
|---|---|---|

Rank of a matrix by echelon form, normal form. Solving system of homogeneous and non-homogeneous linear equations. Eigen values and Eigenvectors and their properties (without proof), Cayley-Hamilton theorem (without proof), finding inverse and powers of a matrix by Cayley-Hamilton theorem, Diagonalization.

At the end of the Module 1, student will be able to:

1. Solving system of linear equations. (BL-3)
2. Determine the rank, eigen values and eigenvectors. (BL-3)
3. Find the inverse and powers of a square matrix by Cayley-Hamilton Theorem. (BL-1)

| MODULE -2 | Higher Order Ordinary Differential Equations with Constant Coefficients | Hours: 14h(11L+3T) |
|---|---|---|

| | | |
|---|---|---|
| Definitions, homogenous and non-homogenous, Complimentary function, general solution, particular integral, method of variation of parameters. applications to L-C-R Circuits | | |
| At the end of the Module 2, students will be able to:<br>1. Identify the essential characteristics of linear differential equations with constant coefficients. (BL-3)<br>2. Solve the linear differential equations with constant coefficients by appropriate method. (BL-3)<br>3. Classify and interpret the solutions of linear differential equations. (BL-2)<br>4. Solve the higher order differential equation by analyzing physical situations. (BL-3) | | |
| **MODULE-3** | **Mean Value Theorems and Multivariable Calculus** | **Hours: 12h (9L+3T)** |
| Taylor's and Maclaurin's theorems with remainders (without proof), related problems, Partial differentiation, Chain rule, Total derivative, Jacobians, maxima and minima of functions of two variables, method of Lagrange's multipliers. | | |
| At the end of the Module 3, students will be able to:<br>1. Translate the given function as series of Taylor's and Maclaurin's with remainders. (BL-2)<br>2. Find the maximum and minimum values of the function for two variables. (BL-1)<br>3. Apply Jacobian concept to deal with problems in change of variables. (BL-3) | | |
| **MODULE-4** | **Partial Differential Equations** | **Hours: 10h (7L+3T)** |
| Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, Solutions of first order linear partial differential equations using Lagrange's method, Solutions of first order non-linear partial differential equations- Standard forms-I, II, III and IV, Method of separation of variables. | | |
| At the end of the Module 4, students will be able to:<br>1. Identify the basic properties of partial differential equations. (BL-3)<br>2. Outline partial differential equations. (BL-2)<br>3. Solve the applications of PDE by using the method of separation of variables. (BL-3)<br>4. Apply the PDE techniques in various engineering fields. (BL-3) | | |
| **MODULE-5** | **Multiple Integrals** | **Hours: 12h(9L+3T)** |
| Double integrals, change of order of integration, change of variables. Evaluation of Triple integrals, change of variables between Cartesian, Cylindrical and Spherical polar coordinates. Finding areas and volumes using double and triple integrals. | | |
| At the end of the Module 5, students will be able to:<br>1. Find the area bounded by a region using double integration. (BL-1)<br>2. Solve triple integrals. (BL-3)<br>3. Make Use of multiple integral techniques in engineering problems. (BL-3) | | |
| | **Total hours** | **64h (48L+16T)** |

**Content beyond syllabus:**

1. L-U decomposition.
2. Deflection of Beams.
3. Taylor's series for function of two variables.
4. Homogeneous Linear Partial differential equations with constant coefficients.
5. Calculation of mass, Centre of gravity, moment of inertia.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Matrices | CO1 | https://youtu.be/P2pL5VThrzQ |
| 2 | Higher Order Ordinary Differential equations with constant coefficients | CO2 | https://youtu.be/P7gVp333B6M<br>https://youtu.be/btOCUmJkrrg |
| 3 | Mean value theorems & Multivariable Calculus | CO3 | https://youtu.be/bJPuy0QZ-tE<br>https://youtu.be/0apMXhWG_W8 |
| 4 | Partial Differential Equations | CO4 | https://youtu.be/kZ7Oa7iMiCs |
| 5 | Multiple Integrals | CO5 | https://youtu.be/mIeeVrv447s |

**Text Books:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

**Reference Book(s):**

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, 2019 Narosa Publishing house
2. B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education,2017
3. H. K. Das, Er. RajnishVerma, Higher Engineering Mathematics, S. Chand,2014
4. N. Bali, M. Goyal, C. Watkins, Advanced Engineering Mathematics, Infinity Science Press,9th edition 2020.

**Online Resources/ Web References:**

1. http://www.macs.hw.ac.uk/~simonm/linalg.pdf
2. http://www.e-booksdirectory.com/details.php?ebook=7400re
3. http://www.efunda.com/math/math_home/math cfm
4. http://www.ocw.mit.edu/resources/#Mathematics
5. http://www.sosmath.com/
6. http://www.mathworld.wolfram.com/

# NARAYANA ENGINEERING COLLEGE (AUTONOMOUS) :: GUDUR

| I-B.Tech | APPLIED PHYSICS (21PH1001) | | | | | | | R2021 |
|---|---|---|---|---|---|---|---|---|
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Mathematics Knowledge, Basics concepts of Physics

**Course Objectives:**

1. To understand optical phenomenon i.e. interference and diffraction related to their engineering applications.
2. To explain the concepts and difference between classical free electron theory and quantum theory.
3. To impart knowledge in basic concepts of free electron theory of metals and semiconductors.
4. To illustrate the concepts of superconductor and nanomaterials in functioning of electronic devices.
5. To familiarize the types of laser/optical fibres and their applications in communication engineering devices

| **Course Outcomes**: After successful completion of the course, the student will be able to: | | BTL |
|---|---|---|
| **CO 1** | Explain the conecpts of interference, diffraction using Huygen's wave theory | 2 |
| **CO 2** | Comprehend the conecpts of matter waves, wave functions and their interpretation for understanding the matter at atomic scale | 1 |
| **CO 3** | Summarize the importance of free electron theories in determining the properties of metals and semiconductors | 1 |
| **CO 4** | Understand the concepts of superconductor and nanomaterials to familarize their applications in relevant fields | 2 |
| **CO 5** | Realize the importance of the lasers and optical fibres in engineering and medical applications | 2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | | | | | | | | | | | | |
| CO2 | 3 | 2 | | | | | | | | | | | | |
| CO3 | 3 | 2 | | | | | | | | | | | 1 | |
| CO4 | 3 | | | | | 1 | | | | | | | 1 | |
| CO5 | 3 | 1 | | | | 1 | | | | | | | 1 | |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

| MODULE – 1 | WAVE OPTICS | 10 HOURS |
|---|---|---|

**Interference**-Principle of Superposition, Interference of light, Conditions for sustained Interference, derivation of conditions for constructive and destructive interference of reflected light from a thin film, Newton's Rings-experimental arrangement, Determination of Wavelength; engineering applications of Interference

**Diffraction**-distinction between interference and diffraction, differences between Fresnel & Fraunhoffer diffractions, Fraunhoffer Diffraction at single slit(derivation, energy distribution curve) , Fraunhoffer Diffraction at a Double slit (derivation, energy distribution curve),Theory of Diffraction Grating, Engineering applications of diffraction

At the end of the Module 1, students will be able to:

1. **Explain** the need of coherent sources and the conditions for sustained interference (L2)
2. **Identify** engineering applications of interference including homodyne and heterodyne detection (L3)
3. **Analyze** the differences between interference and diffraction with applications (L4)

| MODULE -2 | INTRODUCTION TO QUANTUM MECHANICS | 9 HOURS |
|---|---|---|

Matter waves –de-Broglie hypothesis- properties, G.P.Thomson experiment, Phase and group velocities—Expression for group velocity; Heisenberg's uncertainty principle; Schrodinger's time dependent and independent wave equations – Physical significance of wave function-important characteristics of wave function, Eigen values and Eigen functions of a particle confined to one dimensional infinite square well (potential well).

At the end of the Module 2, students will be able to:

1. **Explain** Quantum Mechanics to understand wave particle dualism (L2)
2. **Necessity** of quantum mechanics to explore the behavior of sub atomic particles (L3)
3. **Evaluate** the Eigen values and Eigen functions of a particle (L2)

| MODULE-3 | FREE ELECTRON THEORY OF METALS & SEMICONDUCTORS | 10 HOURS |
|---|---|---|

Classical free electron theory-assumptions, expression for electrical conductivity, merits and demerits; Quantum free electron theory of metals-expression for electrical conductivity; Fermi-Dirac distribution, Mathiesson rule, causes of electrical resistance in metals, Bloch's theorem (Qualitative), Kronig - Penny Model (Qualitative), Classification of solids into conductors, semiconductors and insulators based on energy band gap.

Semiconductors- Introduction – Intrinsic and Extrinsic semiconductors– Density of charge carriers, Electrical conductivity, Fermi level of intrinsic semiconductors ; Hall effect – Hall coefficient – Applications of Hall effect.

At the end of the Module 3, students will be able to:

1. **Demonstrate** the success of quantum free electron theory over classical free electron theory (L2)
2. **Examine** the probability of occupancy of an electron in an energy state at different temperatures (L3)
3. **Outline** the properties of n-type and p-type semiconductors and charge carriers (L2)
4. **Identify** the type of semiconductor using Hall effect (L2)

| MODULE-4 | SUPERCONDUCTORS AND NANOMATERIALS | 10 HOURS |
|---|---|---|

Superconductors- Introduction – Properties of superconductors – Meissner effect – Type I and Type II superconductors – BCS theory – Josephson effects (AC and DC) – Applications of superconductors.

Nanomaterials– Significance of nanoscale , Properties of nanomaterials: Physical, mechanical, Magnetic, Optical ; Synthesis of nanomaterials: Top-down-Ball Milling, Bottom-up –Chemical vapour deposition ;Applications of Nano materials.

At the end of the Module 4, students will be able to:

1. **Explain** how electrical resistivity of solids changes with temperature (L2)
2. **Classify** superconductors based on Meissner's effect (L2)
3. **Explain** Meissner's effect, BCS theory & Josephson effect in superconductors (L2)
4. **Identify** the nano size dependent properties of nanomaterials (L2)
5. **Illustrate** the methods for the synthesis (L2)
6. **Apply** the basic properties of nanomaterials in various Engineering branches (L3).

| MODULE-5 | LASERS & OPTICAL FIBERS | 9 HOURS |
|---|---|---|

Lasers: Introduction, properties of lasers: monochromaticity, coherence, directionality, brightness; Spontaneous & stimulated emission of radiation, Einstein coefficients, Population inversion, Pumping methods, Types of lasers: Nd- YAG Laser, He–Ne Laser, Semiconductor laser; Applications.

Introduction to Optical Fibers-Total Internal Reflection-Critical angle of propagation-Acceptance angle-Numerical Aperture-Classification of optical fibers based on materials, modes and refractive index profile-Applications: fiber optic communication system and sensors.

At the end of the Module 5, students will be able to:

1. **Understand** the basic concepts of LASER light Sources (L2)
2. **Apply** the concepts to learn the types of lasers (L3)
3. **Identify** the Engineering applications of lasers (L2)
4. **Explain** the working principle of optical fibers (L2)
5. **Classify** optical fibers based on refractive index profile and mode of propagation (L2)

**Total hours: 48 hours**

**Content beyond syllabus:**

Types of magnetic materials and the applications.

Characterization of nano materials: (a) X-ray diffraction & Scanning electron microscope

**Self-Study:**

Contents to promote self-Learning:

| S.No | Topic | CO | Reference |
|---|---|---|---|
| 1 | Wave optics | CO1 | https://nptel.ac.in/courses/122/107/122107035/ |
| 2 | Introduction to quantum mechanics | CO2 | https://nptel.ac.in/courses/115/101/115101107/ |
| 3 | Free electron theory of metal & Semiconductors | CO3 | https://nptel.ac.in/courses/113/106/113106040/ https://nptel.ac.in/courses/115/102/115102025/ |
| 4 | Superconductors and nanomaterials | CO4 | https://nptel.ac.in/courses/115/101/115101012/ https://nptel.ac.in/courses/118/104/118104008/ |
| 5 | Lasers & optical fibers | CO5 | https://nptel.ac.in/courses/115/102/115102124/ https://nptel.ac.in/courses/115/107/115107095/ |

**Text Book(s):**


1. M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy" AText book of Engineering Physics"- S. Chand Publications, 11th Edition 2019.
2. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning, 2012.
3. S.O.Pillai, "Solid State Physics", 8th edition, New Age International Publishers, 2018.


**Reference Book(s):**


1. Shatendra Sharma, Jyotsna Sharma, " Engineering Physics", Pearson Education,2018
2. N. Subrahmanyam, BrijLal, A Textbook of Optics, S. Chand, New Delhi, 2015
3. Kittel, C. Introduction to Solid State Physics‖. Wiley, 2005.
4. K. Thyagarajan, Engineering Physics, McGraw-Hill Education (India) Pvt. Ltd, 2016.
5. Ajoy Ghatak, Optics, 5th Edition, McGraw Hill, 2012
6. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.
7. William T. Silfvast, "Laser Fundamentals" 2nd edition, Cambridge University Press, 2004.
8. T. Pradeep, "A Text Book of Nanoscience and Nanotechnology", Tata Mc Graw Hill, 2003


**Online Resources:**

https://www.youtube.com/watch?v=-mNQW5OShMA
https://www.youtube.com/watch?v=TwlRVDM6bKY
https://www.youtube.com/watch?v=lH9SNnQCs54&t=58s
https://www.youtube.com/watch?v=Usu9xZfabPM&t=154s

https://www.youtube.com/watch?v=x4Nr93ALNjo
https://www.youtube.com/watch?v=FL4QCymhYDA
https://www.youtube.com/watch?v=PvN-cwQXBDc
https://www.youtube.com/watch?v=RAqgxH_pS7Y
https://www.youtube.com/watch?v=AhLATP5rYPs
https://www.youtube.com/watch?v=CjAVfW_6juw
https://www.youtube.com/watch?v=h6FYs_AUCsQ
https://www.youtube.com/watch?v=3-PQ8H-AI9c
https://www.youtube.com/watch?v=3-PQ8H-AI9c
https://www.youtube.com/watch?v=PNElByWIGNc
https://www.youtube.com/watch?v=1xWBPZnEJk8
https://www.youtube.com/watch?v=WgzynezPiyc
https://www.youtube.com/watch?v=T94BbyYyNpg
https://www.youtube.com/watch?v=aqazAcE19vw

**Web Resources:**

1.http://www.sfu.ca/phys/141/1134/Lectures/SP%20Lecture%2029%20-%20Interference&Diffraction.pdf

2.http://pages.physics.cornell.edu/~ajd268/Notes/QM-Notes.pdf

3.http://www-rjn.physics.ox.ac.uk/lectures/metalsnotes10.pdf

4.https://www.iare.ac.in/sites/default/files/lecture_notes/semiconductors%20lecture%20notes%20%281%29_0.pdf

5.http://www.gpcet.ac.in/wp-content/uploads/2018/09/UNIT-5-EP-PDF.pdf

6.https://galgotiacollege.edu/assets/pdfs/study-material/notes-Physics.pdf

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B.Tech | BASIC ELECTRICAL CIRCUITS (21ES1003) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Fundamental of mathematics and physics**

**Course Objectives:**

1. To study the basics of circuit analysis.
2. To study the magnetic circuits.
3. The concepts of real power, reactive power, complex power, phase angle and phase difference.
4. To understand frequency response in electrical circuits.
5. To understand the concept of graphical solution to electrical network.
6. To impart knowledge on solving circuit equations using network theorems.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Solve various electrical networks in presence of active and passive elements.(BL-3) |
| **CO 2** | Understand the fundamental behaviour of AC circuits and solve AC circuit problems.(BL-2) |
| **CO 3** | Explain the behaviour of the circuit at series & parallel resonance of circuit & the effect of resonance .(BL-2) |
| **CO 4** | Apply graph theory to formulate network equations.(BL-3) |
| **CO 5** | Solve electrical networks by using principles of network theorem.(BL-3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 1 | | | | | | | | | 3 | 3 | 1 |
| CO2 | 3 | 3 | 3 | | | | | | | | | | 2 | |
| CO3 | 3 | 3 | 3 | | | | | | | | | | 3 | 3 |
| CO4 | 3 | 3 | 3 | | | | | | | | | | 2 | 3 |
| CO5 | 3 | 3 | 2 | | | | | | | | | | | |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | | |
|---|---|---|
| **MODULE – 1** | **INTRODUCTION TO ELECTRICAL & MAGNETIC CIRCUITS** | **11hours** |

Network elements, R, L and C Parameters, Kirchhoff's Laws - Independent and Dependent sources-Source Transformation, Network Reduction Techniques, Faraday's Laws of Electromagnetic Induction, Concept of Self and Mutual Inductance, Dot Convention, Coefficient of Coupling, Composite Magnetic Circuit, MMF Calculations.

At the end of Module 1, students will be able to:

1. Explain the network elements.(BL-2)
2. Understand the Voltage, Current, Power, Direct Current (DC), Alternating Current.(BL-2)
3. Explain the laws of electromagnetic induction.(BL-2)
4. Explain the Single phase AC circuits.(BL-2)

| | | |
|---|---|---|
| **MODULE -2** | **SINGLE PHASE AC CIRCUITS** | **10hours** |

| | | |
|---|---|---|
| Introduction, R.M.S, Average Values and Form Factor for Different Periodic Wave Forms. Phase and Phase Difference, Steady State Analysis of R, L, C With series and parallel Sinusoidal Excitation. | | |
| At the end of the Module 3, students will be able to:<br>1. Understand the advantages of single phase AC system. (BL-2)<br>2. Explain the complex and polar forms representation.(BL-2)<br>3. Find the AC circuits in order to determine the voltage, current and power for the given problem. (BL-2) | | |
| **MODULE -3** | **RESONANCE & LOCUS DIAGRAMS** | **10hours** |
| Resonance: Introduction, Series Resonance and parallel resonance, resonance frequency, Q-factor, Bandwidth, Locus diagrams of RL, RC and RLC circuits and problems. | | |
| At the end of the Module 4, students will be able to:<br>1. Explain AC circuits along with resonance and locus diagrams.(BL-2)<br>2. Understand the effect of resonance on series and parallel resonance circuits.(BL-2)<br>3. Explain the frequency response for a resonant circuits.(BL-2) | | |
| **MODULE -4** | **NETWORK TOPOLOGY** | **9hours** |
| Definitions – Graph – Tree, Incidence Matrix, Basic Cutset and Tieset matrices for planar networks - Nodal Analysis, Mesh Analysis, Super Node and Super Mesh Analysis for Dependent and Independent Voltage and Current Sources and DC & AC Excitations - Duality and Dual Networks. | | |
| At the end of the Module 5, students will be able to:<br>1. Understand the overview of topology for a given network. (BL-2)<br>2. Find the graph for the given electrical network. (BL-2)<br>3. Apply graph theory to solve network equations. (BL-3) | | |
| **MODULE-5** | **NETWORK THEOREMS** | **08hours** |
| Superposition theorem, Compensation theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Tellegen's theorem, Millman's theorem, Reciprocity theorem; Application of network theorems in solving DC and AC circuits. | | |
| At the end of the Module 6, students will be able to:<br>1. Understand the way of approaching to solve for a given network. (BL-2)<br>2. Solve theorems for finding the solutions of network problem.(BL-3)<br>3. Explain the application of network theorems.(BL-2) | | |
| | **Total hours:** | **48hours** |

**Content beyond syllabus:**

1. Three Phase circuits and its Importance in Electrical Engineering.
2. Real time applications of network theorems.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | Reference |
|---|---|---|
| 1 | Introduction to the electrical & magnetic circuits | https://nptel.ac.in/courses/117/106/117106108/ |
| 2 | Single phase AC circuit | https://nptel.ac.in/courses/108/105/108105053/ |
| 3 | Locus diagram and resonance | https://nptel.ac.in/courses/108/105/108105112/ |
| 4 | Analysis of electrical circuit and Graph theory | https://nptel.ac.in/courses/108/105/108105159/ |

| | | |
|---|---|---|
| 5 | Network theorem | https://nptel.ac.in/courses/117/106/117106108/ |

**Text Book(s):**

1. A Sudhakar and Shyam Mohan S P, “Circuits and Networks: Analysis and Synthesis”, TMH, 5th Edition, New Delhi, 2015.
2. Ravish R., Network Analysis and Synthesis, 2/e, McGraw-Hill, 2015

**Reference Book(s):**

1. S.Sivanagaraju, G.Kishore & C.Srinivasa Rao, "Electrical Circuit Analysis", Cengage Learning, 1st Edition, 2010.
2. A. Chakrabarti : Circuit Theory (Analysis and Synthesis), Dhanpat Rai &Co
3. Joseph A. Edminister and Mahmood Nahvi, “Electric Circuits Schaum’s Outline Series”, 6th Edition, Tata McGraw-Hill, 2014, New Delhi.
4. Electric Circuits by N.Sreenivasulu, REEM Publications

**Online Resources / Web Reference:**

**1.** https://nptel.ac.in/courses/108/105/108105159/
**2.** https://nptel.ac.in/courses/108/102/108102042/
3. https://nptel.ac.in/content/storage2/courses/108105053/pdf/L-21(TB)(ET)%20((EE)NPTEL).pdf
4. https://en.wikibooks.org/wiki/Circuit_Theory
5. http://www.mathtutordvd.com/products/Engineering-Circuit-Analysis-Volume-1.cfm
6. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-andelectronics-spring-2007/video-lectures/lecture-2/
7. http://www.facstaff.bucknell.edu/mastascu/elessonsHTML/Circuit/Circuit1.html
8. https://opencourses.emu.edu.tr/course/view.php?id=3

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Semester | PROBLEM SOLVING AND PROGRAMMING | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 48 | 3 | 30 | 70 | 100 |

**Pre-requisite:** Mathematics Knowledge, Analytical and Logical skills

**Course Objectives:**

1. To understand various steps in Program development.
2. To understand the basic concepts in C Programming Language.
3. To learn how to write modular and readable C Programs.
4. To learn the syntax and semantics of a C Programming language.
5. To learn structured programming approach for problem solving.

**Course Outcomes**: After successful completion of the course, Student will be able to:

| | |
|---|---|
| **CO 1** | Identify methods to solve a problem through computer programming. (BL - 3) |
| **CO 2** | Understand the use of basic elements of C language. (BL - 2) |
| **CO 3** | Understand the usage of various control statements and the modular approach for solving the problems. (BL - 2) |
| **CO 4** | Apply the Arrays and Pointers for solving problems. (BL - 3) |
| **CO 5** | Explain User-Defined Data Types and Files. (BL - 2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO3 | PO4 | PO5 | PO6 | PO 7 | PO 8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | | | | | | | | | | | 1 | |
| CO2 | 1 | 2 | 1 | | | | | | | | | | 1 | |
| CO3 | 1 | 2 | 3 | 2 | 2 | | | | | | | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | | | | | | | | 1 | 2 | |
| CO5 | 2 | 2 | 2 | 2 | | | | | | | | 1 | 2 | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Fundamentals of Computers and Programming | 9 H |
|---|---|---|

**Introduction to Programming, Algorithms and Flowcharts:** Programs and Programming, Programming languages, Compiler, Interpreter, Structured Programming Concept, Algorithms, Flowcharts, How to Develop a Program.

**Fundamental Algorithms:** Exchanging the values of Two Variables, Counting, Summation of a set of numbers, Factorial computation, Generation of the Fibonacci Sequence, Reversing the digits of an integer.

At the end of the Module 1, students will be able to:

1. Solve problems using language independent notations. (BL - 3)
2. Understand the compilers and interpreters. (BL - 2)
3. Understand Structured Programming. (BL - 2)
4. Develop algorithms and flowcharts for problems. (BL - 3)

| MODULE -2 | Basic Elements of C | 9 H |
|---|---|---|

**Basics of C:** Introduction**,** Character Set, Structure of a C Program, A Simple C Program, Variables, Data Types and Sizes, Declaration, How does The Computer Store Data in Memory, Identifiers, Keywords, Constants, Assignment, and Initialization.

**Operators and Expressions:** Arithmetic Operators, Relational Operators, Logical Operators, Bitwise Operators, Conditional Operator, Comma operator, sizeof operator, Expressions, L values and R values, Expression Evaluation- Precedence and Associativity, Type Conversion.

At the end of the Module 2, students will be able to:

1. Understand the basic structure of a program in C. (BL - 2)
2. Understand tokens in C language. (BL - 2)
3. Illustrate the working of expressions. (BL - 2)
4. Understand the precedence and Associativity rules of operators. (BL - 2)
5. Understand the rules of type conversion. (BL - 2)

| MODULE-3 | Data Input / Output, Control Statements and Functions | 11 H |
|---|---|---|

**Input and Output:** Basic Screen and Keyboard I/O in C, Formatted Input and Output, Unformatted Input and Output Functions

**Control Statements:** Selection Statements - if, Nested if, if-else, Nested if-else, else-if ladder, switch, Looping Statements - while, do-while, for, Nested loops, Unconditional Statements - goto, break, continue, return.

**Functions:** Introduction, Using Functions, Passing Arguments to a Function, Working with Function, Scope and Extent, Recursion, The C Preprocessor, Storage classes, Multifile programs.

At the end of the Module 3, students will be able to:

1. Explain the Formatted and Unformatted I/O functions. (BL - 2)
2. Understand Selection Statements. (BL - 2)
3. Understand Looping Statements. (BL - 2)
4. Explain Unconditional Statements. (BL - 2)
5. Understand the basic concept of functions. (BL - 2)
6. Understand concept of Recursion and Preprocessor. (BL - 2)
7. Explain storage specifiers. (BL - 2)

| MODULE-4 | Arrays and Pointers | 10 H |
|---|---|---|

**Arrays and Strings:** Introduction, One-Dimensional Array, Multidimensional Arrays, Passing Arrays to Function, Strings - Declaration, Initialization, Printing Strings, String Input, Character Manipulation, String Manipulation, Arrays of Strings.

**Pointers:** Fundamentals, Pointer Declarations, Operations on pointers, Passing Pointers to a Function, Pointers and Arrays, Arrays of Pointers, Pointer to Pointer, Pointer to Functions,

| | | |
|---|---|---|
| Command line arguments, Dynamic Memory Management. | | |
| At the end of the Module 4, students will be able to:<br>1. Understand the concept of Arrays. (BL - 2)<br>2. Understand the concept of pointers. (BL - 2)<br>3. Explain Dynamic Memory Management. (BL -2) | | |
| **MODULE-5** | **User-Defined Data Types and Files** | **9 H** |
| **Structures and Unions:** Basics of Structures, Nesting of Structures, Arrays of Structures, Structures and Pointers, Structures and Functions, Self-Referential Structures, Unions, Bit-fields, Enumerations, typedef.<br>**Files:** Introduction, Using Files in C, Working with Text Files, Random Accesses to Files of Records. | | |
| At the end of the Module 5, students will be able to:<br>1. Explain user defined data types. (BL - 2)<br>2. Understand the concept of Self-Referential Structures. (BL - 2)<br>3. Understand the working of files. (BL - 2) | | |
| | **Total hours:** | **48 HOURS** |

**Content Beyond Syllabus:**

1. Analysis of Algorithms
2. Binary Files
3. Variable Length Argument Lists

**Self-Study:**

Contents to promote self-Learning:

| SNo | Module | Reference |
|---|---|---|
| 1 | Fundamentals of Computers and Programming | https://nptel.ac.in/courses/106/106/106106127/ [ Lec 1 ]<br>https://nptel.ac.in/courses/106/105/106105171/ [ Week 1 - Lec 1 To 4 ] |
| 2 | Basic Elements of C | https://nptel.ac.in/courses/106/105/106105171/ [ Week 1 - Lec 10]<br>https://nptel.ac.in/courses/106/105/106105171/ [ Week 2 - Lecture 7 To 10 ]<br>https://nptel.ac.in/courses/106/105/106105171/ [ Week 3 - Lec 11 To 14 ]<br>https://nptel.ac.in/courses/106/106/106106127/ [ Lec 12 ]<br>https://nptel.ac.in/courses/106/106/106106127/ [ Lec 13 ]<br>https://nptel.ac.in/courses/106/106/106106127/ [ Lec 14 ] |

| | | |
|---|---|---|
| 3 | Data Input / Output, Control Statements and Functions | https://nptel.ac.in/courses/106/106/106106127/ [ Lec 20 ] https://nptel.ac.in/courses/106/105/106105171/ [ Week 4 - Lec 25 ] https://nptel.ac.in/courses/106/105/106105171/ Week 4 - Lec 26 To 28 ] [ Week 5 - Lec 21 To 25 ] https://nptel.ac.in/courses/106/106/106106127/ [ Lec 26 & 27 ] |
| 4 | Arrays and Pointers | https://nptel.ac.in/courses/106/105/106105171/ [ Week 5 - Lec 30 To 32] [ Week 6 - Lec 32 To 34] [ Week 6 - Lec 35,36 ] https://nptel.ac.in/courses/106/106/106106127/ [ Lec 37,38 ] |
| 5 | User-Defined Data Types and Files | https://nptel.ac.in/courses/106/105/106105171/ [ Week 11 - Lec 40,41 ] https://nptel.ac.in/courses/106/106/106106127/ [ Lec 43,44 ] https://nptel.ac.in/courses/106/106/106106127/ [ Lec 47 ] |

**Text Book(s):**

1. Pradip Dey, and Manas Ghosh, "Programming in C", 2018, Oxford University Press.
2. Byron Gottfried, Schaum's Outline of Programming with C, 4th Edition, 2018, McGraw-Hill

**Reference Books :**


1. Brian W. Kernighan, and Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Pearson.
2. Ajay Mittal, Programming in C: A Practical Approach , 3/e, Pearson Publication
3. SCHILDT and HERBERT, C: The Complete Reference,4th Edition, McGraw Hill, 2020
4. SOMASHEKARA, M. T., GURU, D. S., MANJUNATHA, K. S., Problem Solving with C,2nd Edition, PHI Learning, 2018
5. Paul Deitel, Deitel& Harvey Deitel, C How to Program,6th Edition, Pearson Education
6. Jeri R. Hanly, Elliot B. Koffman, Ashok Kamthane and A.Ananda Rao, Programming in C and Data Structures, 1st Edition, Pearson Education, 2010.
7. H.Cheng, C for Engineers and Scientists, Mc.Graw-Hill International Edition Education / PHI, 2009
8. Yashavant P. Kanetkar, Let us C, 16th Edition, BBP Publications, Delhi, 2017.
9. R.G. Dromey, "How to Solve it by Computer". Pearson,2014.
10. Anita Goel, Computer Fundamentals, Pearson Publication,2010.

# NARAYANA ENGINEERING COLLEGE:GUDUR

| I-B.Tech | Applied Physics lab (21PH1501) | | | | | | | R2021 |
|---|---|---|---|---|---|---|---|---|
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 0 | 0 | 2 | 36 | 1.5 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To provide student to learn about some important experimental techniques in physics with knowledge in theoretical aspects so that they can excel in that particular field. To prepare students for performing requirement analysis and design of variety of applications.
2. To enable the students to understand the concepts of interference and diffraction and their applications.
3. To educate students to recognize the applications of laser in finding the wavelength, slit width and its role in diffraction studies
4. To make the students to understand the important parameters of optical fibres and metals

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | learn important concepts of physics through involvement in the experiments by applying theoretical knowledge. |
| **CO 2** | understand the concepts of interference and diffraction and their applications. |
| **CO 3** | recognize the applications of laser in finding the wavelength, slit width and its role in diffraction studies |
| **CO 4** | understand the important parameters of optical fibres and metals |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 1 | | | | | | | | | | | | |
| CO2 | 2 | 1 | | | | | | | | | | | | |
| CO3 | 2 | 1 | | | | 1 | | | | | | | | |
| CO4 | 2 | 1 | | | | 1 | | | | | | | | |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | CO |
|---|---|
| **Task -1** Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall effect. | |
| The objective :To determine<br>a) sign of the charge carriers,<br>b) charge carrier concentration,<br>c) mobility of the charge carriers of a given semiconductor | CO 1 |
| **Task - 2 To determine the resistivity of semiconductor by Four probe method** | |
| Objective: To determine the resistivity of semiconductor by Four probe method | CO 1 |
| **Task -3** Determine the energy gap of a given semiconductor diode. | |
| Objective:To plot characteristics between reverse saturation current and 103 /T and find out the approximate value of Energy Band Gap in PN junction diode | CO 1 |

| | |
|---|---|
| **TASK -4** Measurement of radius of curvature of a lens by Newton's rings method. | |
| Objective:To determine the wavelength of sodium light by Newton's Ring method<br>The key idea behind Newtons ring experiment is the thin film formation between a plane-convex lens and a glass plate. Due to this thin film of air a path difference occurs in the waves which reflect from the lower surface of the lens and the top surface of the glass plate. As a result of it, they superimpose and develop the interference pattern. | CO 2 |
| **TASK -5. Determine the thickness of the wire using wedge shape method** | |
| Objective: To calculate the thickness of a thin wire by forming interference fringes using an air wedge arrangement.<br>The key idea behind this experiment is the formation of thin wedge shaped film between two plane glass plates. Due to this thin film of air, a path difference occurs between waves reflected from top and bottom surface of the film. On superimposition of these waves an interference pattern containing a number of straight line fringes will be produced | CO 2 |
| **TASK-6 Determination of wavelength by plane diffraction grating normal incidence method** | |
| Objectives: 1.To understand the types of diffraction<br>2.To familiarize with the principle of diffraction in plane transmission grating<br>3. To know the procedure for standardization of the grating<br>4.To determine the wavelengths of prominent spectral lines of mercury spectrum.<br>An arrangement, which is equivalents in its action to a large number of parallel slits of same width separated by equal opaque spaces is called diffraction grating. It is constructed by ruling fine equidistant parallel lines on an optically plane glass plate with the help of a sharp diamond point. | CO 2 |
| **TASK -7 Dispersive power of a diffraction grating** | |
| objective: To determine Dispersive power of a diffraction grating<br>When white light passes through a grating, different wavelengths undergo different angles of diffraction. Hence white light split up into different colours and diffraction spectra of different orders will be produced. The angular dispersion or dispersive power of a grating is defined as the rate of change of angle of diffraction with the change of wavelength in a particular order of the spectrum. | CO 2 |
| **TASK -8 Determination of wavelength of LASER light using diffraction grating** | |
| Objectives :1. To determine the concept of diffraction<br>2. To determine the wavelength of the given Laser source. | CO 3 |
| **TASK -9 . Laser: Diffraction at a single slit** | |
| Objective:Determination of width of a given single slit using laser diffraction method<br>Laser beam has high monochromaticity,coherence and directionality. Hence it forms a clear diffraction pattern and we can measure width of a single slit accurately. | CO 3 |
| **TASK -10 To determine the numerical aperture and acceptance angle of a given optical fibre** | |
| Objective: To determine the numerical aperture and acceptance angle of a given optical fiber.<br>In optical fibres light travel by multiple total internal reflections. Numerical aperture represents light gathering powerof optical fibre. Acceptance angle represents maximum limiting angle at one end of optical fibre for the liglht ray to travel by multiple total internal reflections through the core region of thefibre.<br>1. Optical fibers may be used for accurate sensing of physical parameters and fields like pressure, temperature and liquid level. | CO4 |

| | |
|---|---|
| 2. For military applications like fiber optic hydrophones for submarine and underwater sea application and gyroscopes for applications in ships, missiles and aircrafts. | |
| **Additional Experiments:** | |
| **TASK -11 Laser: Diffraction at a double slit** | |
| Objective:Determination of width of a given double slit using laser diffraction method.<br>With this experiment we can demonstrate diffraction nature of lasers and measure width of a double slit accurately. | CO 3 |
| **TASK -12:** Determination of Fermi energy of a metal. | |
| Objective: To determine Fermi energy of a metal.<br>Fermi energy represents highest energy level occupied by the electron at 0 K in a metal. | CO4 |
| Virtual lab: 1) Laser beam divergence and spot size<br>https://vlab.amrita.edu/?sub=1&brch=189&sim=342&cnt=1<br>Michelson's Interferometer- Wavelength of laser beam<br>https://vlab.amrita.edu/?sub=1&brch=189&sim=1106&cnt=1<br>Anderson's Bridge<br>https://vlab.amrita.edu/?sub=1&brch=192&sim=859&cnt=1 | |

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | Reference |
|---|---|---|
| 1 | Newton rings | **https://youtu.be/PU-SeNfIRcs** |
| 2 | Diffraction grating experiment – Wavelength of mercury spectrum | **https://youtu.be/N0lxwqANsd4** |
| 3 | Experiment – Laser Grating-Determination of Wavelength of Given Laser Source | **https://youtu.be/764Fr0mnOrQ** |

**Text Book(s):**

1. C. L. Arora, "Practical Physics", S. Chand & Co., New Delhi, 3rd Edition, 2012.
2. Vijay Kumar, Dr. T. Radhakrishna, "Practical Physics for Engineering Students", S M Enterprises, 2nd Edition, 2014.

**Reference Book(s):**

S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S Chand Publishers, 2017.
C.H. Bernard and C.D. Epp, John Wiley and Sons, "Laboratory Experiments in College Physics" Inc., New York, 1995.
Dr.Ruby Das, C.S.Robinson, Rajesh Kumar and Prasanth Kumar "A text book of Engineering Physics Practical", 1st edition, Sahu University Science Press, 2010.
4.Jayaraman, "Engineering Physics Laboratory Manual", 1st edition, Pearson Education, 2014.

**Web Resources:**

1. https://www.scribd.com/doc/143091652/ENGINEERING-PHYSICS-LAB.
2. https://www3.nd.edu/~wzech/LabManual_0907c.pdf.
3. https://www.morebooks.de/store/gb/book/engineering-physics-lab-manual/isbn/978-3-330-34402.

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B.Tech. | BASIC ELECTRICAL CIRCUIT LAB (21ES1506) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 0 | 0 | 2 | 32 | 1 | 40 | 60 | 100 |

**Pre-requisite: Network Analysis**

**Course Objectives:**

1. Fundamentals of Ohm's law, Kirchhoff's current and voltage laws and its practical implementation.
2. Measurement of voltage, current, power and impedance of any circuit.
3. Analysis of a given circuit depending on types of elements.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Apply the KCL and KVL for circuit analysis and verify the results theoretically (BL= 3) |
| **CO 2** | Experimentally determine self inductance, mutual inductance and coefficient of coupling.(BL=3) |
| **CO 3** | Practically determine band width, Q-factor and verify with theoretical values. (BL=3) |
| **CO 4** | Able to draw locus diagrams, waveforms and phasor diagrams for lagging and leading networks.(BL-2) |
| **CO 5** | Apply suitable theorems for the given Electrical circuit and verify with theoretical values.(BL=3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO5 | 2 | 2 | 1 | | | | 1 | | | | | | 2 | 3 |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | CO |
|---|---|
| **Task 1 – Verification of Kirchhoff's laws** | |
| **Objective:** To verify the KCL and KVL for a given circuit | CO 1 |
| **TASK-2 Determination of Self, Mutual Inductances and Coefficient of Coupling** | |
| **Objective:** To determine the self and mutual inductances and coefficient of coupling for two inductive coils. | CO 1 |
| **TASK-3 Measurement of current in various branches of RLC series and draw the phasor** | CO 2 |
| **diagram.** | |
| **Objective:** To Analyze the series and parallel RLC circuits | |
| **TASK-4 Locus Diagrams of RL, RC Series Circuit.** | |

| | |
|---|---|
| **Objective:**<br>To Plot the current locus diagrams for Series RL,RC circuit. | CO 2 |
| **TASK-5 Frequency response of series & parallel resonance circuit with analysis and design** | |
| **Objective:**<br>To determine resonant frequency, band width and Q-factor for series & parallel RLC circuits | CO 3 |
| **TASK-6 Verification of Thevenin's and Norton's theorems** | |
| **Objective:**<br>To verify the Thevinins and Norton's Theorem | CO 4 |
| **TASK-7 Verification of Reciprocity and Millman's Theorems** | |
| **Objective:**<br>To verify the reciprocity and Millman's Theorems | CO 4 |
| **TASK-8 Verification of Superposition Theorem** | |
| **Objective:**<br>To verify the superposition theorem | CO 4 |
| **TASK-9 Verification of Maximum Power Transfer Theorem** | |
| **Objective:**<br>To verify the Maximum power transfer theorem | CO 4 |
| **TASK-10 Verification of compensation Theorem** | |
| **Objective:**<br>To verify the compensation theorem | CO 4 |

| | |
|---|---|
| **Additional Experiments:** | |
| **TASK-11** Verification of mesh & nodal analysis using digital simulation. | CO 1 |
| **Objective:**<br>To verify mesh analysis using digital simulation. | |
| **TASK-12** Verification of different theorems using digital simulation. | CO 1 |
| **Objective:**<br>To verify different theorems using digital simulation | |
| **Virtual Labs:**<br>1. Parallel RC Circuits<br>2. Parallel LC Circuits<br>3. Thevenin's theorem<br>4. Series RL Circuits<br>5. Norton's Theorem<br>6. Series LCR Circuit | |
| **Self-Study:**<br>Contents to promote self-Learning: | |

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Thevinins and nortons | CO1 | https://www.youtube.com/watch?v=7JfoDFk61o8 |
| 2 | Series Resonance in RLC Circuit | CO2 | https://www.youtube.com/watch?v=YLGrugmDvc0 |
| 3 | Phasor Diagram of RL, RC and RLC Circuits | CO3 | https://www.youtube.com/watch?v=HaFrY0qQ-NU |

| |
|---|
| **Text Book(s):**<br>1. A Chakrabarthy, "Electric Circuits", Dhanpat Rai & Sons, 6th Edition, 2010.<br>2. A Sudhakar, Shyammohan S Palli, "Circuits & Networks", Tata McGraw- Hill, 4th Edition, 2010 |
| **Reference Book(s):**<br>1. Willam Hayt.jr, Jack E.kemmerly,Steven M.Durbin, "Engineering Circuit analysis" Tata McGraw- Hill, 8th Edition2012<br>2. Rudrapratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers", Oxford University Press, 1 st Edition, 1999. |
| **Web References:**<br>1. https://www.ee.iitkgp.ac.in/<br>2. http://www.vlab.co.in/lab_ready_for_use.php<br>3. http://vlab.amrita.edu/?sub=1&brch=75 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B.Tech | ENGINEERING & ITWORK SHOP (21ES1505) | | | | | | | R2021 |
| PART – A ENGINEERING WORK SHOP | | | | | | | | |
| Semester | Hours / Week | | | Total hrs | Credits | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

**Pre-requisite:** Basic mathematics and electronic devices.

**Course Objectives:**

1. To know basic workshop processes and adopt safety practices while working with various tools and equipments
2. To identify, select and use various marking, measuring, holding, striking and cutting tools & equipments.
3. To know about the internal parts of a computer, assembling a computer from the parts, preparing a computer for use by installing the operating system
4. To gain knowledge about the usage of tools like Word processors, Spreadsheets, Presentations
5. To learn about Networking of computers and use Internet facility for Browsing and Searching

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO1** | **Understand** the safety aspects in using the tools and equipments.(BL-2) |
| **CO2** | **Apply** tools for making models in respective trades of engineering workshop.(BL-3) |
| **CO3** | **Apply** basic electrical engineering knowledge to makes imple housewiring circuits And check their functionality.(BL-3) |
| **CO4** | **Understand** to disassemble and assemble a Personal Computer and prepare the Computer ready to use(BL-2) |
| **CO5** | **Apply** knowledge to Interconnect two or more computers for information sharing (BL-3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | 3 | | | | | | | | 1 | 3 |
| CO2 | 2 | | | | 3 | | | | | | | | 1 | 3 |
| CO3 | 2 | | | | 3 | | | | | | | | 1 | 3 |
| CO4 | 2 | | | | 3 | | | | | | | | 1 | 3 |
| CO5 | 2 | | | | 3 | | | | | | | | 1 | 3 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT (TRADES FOR PRACTICE)**

**Trade -1 Carpentry (6 H)**

Familiaritywithdifferenttypesofwoodsandtoolsusedinwoodworkingandmakefollowingjointsfromoutof 300x40x25 mms of two od stock.

a) Half–Lapjoint.

b) Mortise and Tenonjoint

**Trade-2 Fitting (6 H)**

i.]Familiarity with different types of tools used in fitting and do the fitting exercises out of 80 x 50 x 5 mm M.S. stock

a) V-fit b) Dovetail fit

**Trade – 3 Sheet Metal Work (6 H)**

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from out of 22 or 20 guage G.I. sheet
a) Tapered tray b) Conical funnel

**Trade – 4 Electrical House Wiring (6 H)**

Familiarities with different types of basic electrical circuits and make the following electrical connections
a) Two lamps in series
b) Two way switch
c) Tube light
d) Two lamps in parallel with 3 pin plug and switches

**Trade 5 – Welding**

Familiarity with different types of tools used in welding and do the following welding exercises
1. Single V butt joint
2. Lap joint

**Text Book(s):**

1. Hajra Choudhury S.K., Hajra Choudhury A.K., Nirjar Roy S.K. "Elements of WorkshopTechnology"Vol-I2008&Vol-II2010MediaPromoters&Publishers Pvt.Limited,Mumbai.
2. KalpakjianS.andStevenS.Schmid,"Manufacturing Engineering and Technology" 4thEdition, Pearson Education IndiaEdition,2002.
3. P. Kannaiah&K. L. Narayana "Workshop manual" 2ndEd., Scitech publications Pvt.Ltd.,Hyderabad,2008.

**Reference Book(s):**

2. Gowri P., Hariharan and Suresh Babu A., "Manufacturing Technology-I", Pearson Education2008.

**WebResources:**

1. https://www.muet.edu.pk/sites/default/files/images/users/41/Workshop%20Intro.pdf
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=98826

## PART-B IT WORKSHOP LAB

**Course Objectives:**

1. To provide Technical training on Productivity tools like Word processors, Spreadsheets, Presentations.
2. To make the students know about the internal parts of a computer, assembling, installing the operating system.
3. To teach connecting two or more computers.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand functionalities of a computer and operating system. (BL-2) |
| **CO 2** | Practice Word processors, Presentation and Spreadsheet tool. (BL-2) |
| **CO 3** | Connect computer using wired and wireless connections. (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 1 | | | | | | | | | | | | | |
| CO2 | 1 | | | | | | | | | | | | | |
| CO3 | 1 | | | | | | | | | | | | | |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | CO |
|---|---|
| **Task-1 Learn about Computer (4H)** | |
| Identify the internal parts of a computer and its peripherals. Represent the same in the form of diagrams including Block diagram of a computer. Write specifications for each part of a computer including peripherals and specification of Desktop computer. Submit it in the form of a report. | CO 1 |
| **Task -2 Assembling a Computer (4H)** | |
| Disassemble and assemble the PC back to working condition. Troubleshoot the computer and identify working and non-working parts. Identify the problem correctly by various methods available (eg: beeps). Record the process of assembling and trouble-shooting a computer. | CO 1 |
| **Task-3 Install Operating system (2H)** | CO 1 |
| Install Linux, any other operating system (including proprietary software) and make the system dual boot or multi boot. Record the entire installation process. | |
| **TASK-4 Operating system features (2H)** | CO 1 |
| Record various features that are supported by the operating system(s) installed. Submit a report on it. Access CD/DVD drives, write CD/DVDs, access pen drives, print files, etc. Install new application software and record the installation process. | |
| **TASK-5 Word Processor (6H)** | CO 2 |
| Create documents using the word processor tool. Tasks to be performed are inserting and deleting the characters, words and lines, Alignment of the lines, Inserting header and Footer, changing the font, changing the colour, including images and tables in the word file, making page setup, copy and paste block of text, images, tables, linking the images which are present in other directory, formatting paragraphs, spell checking, etc. Prepare project cover pages, content sheet and chapter pages at the end of the task using the features studied. Submit a report of the word processor considered. | |

| | |
|---|---|
| Create documents using the word processor tool. Mail Merge in word processor for creating appointment orders for 10 employee records in excel. | |
| **TASK-6 Spreadsheet (4H)** | CO 2 |
| To create, open, save the spreadsheet and format them as per the requirement. Some of the tasks to be practiced are Managing the worksheet environment, creating cell data, inserting and deleting cell data, format cells, adjust the cell size, applying formulas and functions, preparing charts, sorting cells, working with pivot tables and charts. Submit a report of the Spreadsheet application considered. | |
| **TASK-7 Presentations (6H)** | CO 2 |
| To create, open, save and run the presentations, Select the style for slides, format the slides with different fonts, colors, create charts and tables, insert and delete text, graphics and animations, bulleting and numbering, hyperlink, set the time for slide show, Record slide show. Submit a report of the Presentation tool considered. | |
| **TASK-8 Wired network & Wireless network (4H)** | CO 3 |
| Select a LAN cable, Identify the wires in the cable, Define the purpose of each wire, Study the RJ45 connecter, Use crimping tool to fix the cable to the connecter, Test the cable using LAN tester, Connect two or more computers using cross and straight cables, Configure the computers, share the data between the computers. | |

| | |
|---|---|
| **Additional Experiments:** | |
| **TASK -1 IoT** | CO 3 |
| Raspberry Pi Study the architecture of Raspberry pi, configure software, Install SD card, Connect the cables, Install Raspbian (or any other) operating system, Configure Wi-Fi, Remotely connect to your Raspberry Pi. | |
| **TASK -2 OUTLOOK, MACROS** | CO 3 |
| Practice the following tasks and submit report<br>A. Configure outlook and access mails.<br>B. Create Macros in word and spreadsheet tools | |
| | |

**Text Book(s):**

1. B.Govindarajulu, "IBM PC and Clones Hardware Trouble shooting and Maintenance",2nd edition, Tata McGraw-Hill, 2002
2. "MOS study guide for word, Excel, Powerpoint& Outlook Exams", Joan Lambert, Joyce Cox, PHI.
3. "Introduction to Information Technology", ITL Education Solutions limited, Pearson Education.

**Reference Book(s):**

1. Rusen, "Networking your computers and devices", PHI
2. Bigelows, "Trouble shooting, Maintaining & Repairing PCs", TMH.

**On-line/Web Resources:**

https://turbofuture.com/computers/Dissassembling-and-Assembling-the-computer-system
https://www.instructables.com/id/Disassemble-a-Computer/
https://www.windowscentral.com/how-do-clean-installation-windows-10
https://www.tutorialspoint.com/ms_excel_online_training/index.asp
https://www.raspberrypi.org

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B.Tech | Problem Solving and Programming Lab (21ES1501) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

**Pre-requisite:** Mathematics Knowledge, Analytical & Logical Skills

**Course Objectives:**

1. To work with the compound data types
2. To explore dynamic memory allocation concepts
3. To design the flowchart and algorithm for real world problems
4. To write C programs for real world problems using simple and compound data types
5. To employee good programming style, standards and practices during program development

**Course Outcomes**: After successful completion of the course, Student will be able to:

| | |
|---|---|
| **CO 1** | Translate algorithms into programs ( In C language) ( BL - 2) |
| **CO 2** | Code and debug programs in C program language using various constructs.( BL - 3) |
| **CO 3** | Solve the problems and implement algorithms in C. (BL - 3) |
| **CO 4** | Make use of different data types to handle the real time data (BL - 3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO 2 |
| CO1 | 1 | 2 | | | | | | | | | | | 1 | |
| CO2 | 2 | 2 | 2 | | | | | | | | | | 2 | 1 |
| CO3 | 2 | 2 | 3 | 1 | 2 | | | | | | | | 2 | 2 |
| CO4 | 2 | 2 | 3 | 1 | 1 | | | | | | | | 2 | 2 |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | CO |
|---|---|
| **TASK-1 (3H)** | |
| 1Practice DOS and LINUX Commands necessary for execution of C Programs.<br>2Study of the Editors, Integrated development environments, and Compilers in chosen platform.<br>3Write, Edit, Debug, Compile and Execute Sample C programs to understand the Programming environment. | CO 1 |
| **TASK-2 (3H)** | |
| 1. Practice programs: Finding the sum of three numbers, exchange of two numbers, largest of two numbers, to find the size of data types, Programs on precedence and Associativity of operators, sample programs on various library functions. | CO 1 |
| **TASK-3 (6H)** | |
| 1.Write a program to find the roots of a Quadratic equation. | CO1 |

| | |
|---|---|
| 2.Write a C program to calculate the factorial of a given positive integer.<br>3.Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 & 1. Subsequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of the sequence. | |
| **TASK-4 (6H)** | |
| 4.Write a C program to find the sum of individual digits of a positive integer.<br>1. Write a program to reverse the digits of a number.<br>2. Write a program to generate the series of prime numbers in the given range.<br>7.Write a program to check for number palindrome. | CO 2 |
| **TASK-5 (6H)** | |
| 1.Write a C program for the following that use both recursive & non-recursive functions:<br>a. To calculate the factorial of a given positive integer.<br>b. To find the greatest common divisor of two given integers.<br>c. To generate Fibonacci series.<br>2.Illustrate the use of auto, static, register and external variables. | CO 2 |
| **TASK-6 (3H)** | |
| 1.Write a program to find the sum of positive and negative numbers in a given set of numbers.<br>2.Write C code to reverse the elements of the array. For example, [1,2,3,4,5] should become [5,4,3,2,1]<br>3.Write a program to find the maximum of a set of numbers. | CO 3 |
| **TASK-7 (6H)** | |
| 1.Write a C program that use pointers to find Addition of Two Matrices<br>2.Write a C program that use functions to find Multiplication of Two Matrices | CO 3 |
| **TASK-8 (3H)** | |
| 1.Write a program to accept a line of characters and print the number of vowels, Consonants, blank spaces, digits and special characters.<br>2. Write a C program to check whether a given string is a palindrome or not, without using any built-in functions. | CO 3 |
| **TASK-9 (6H)** | |
| 1.Write a C program to find the length of a given string using pointers.<br>2.Write a C program to add two distances in feet and inches using structure<br>3.Write a C program to read and print an employee's detail using structure<br>4. Write a C program to read and print book information using union | CO 4 |
| **TASK-10 (6H)** | |
| 1.Write a program to split a "file" into two files, say file1 and file2. Write lines into the 'file' from standard input. Read the contents from 'file' and write odd numbered lines into file1 and even numbered lines into file2.<br>2.Write a program to merge two files. | CO 4 |
| **ADDITIONAL TASKS** | |
| 1.Write a program to find the Abundant Number<br>2.Write a program to insert the element in a given position | |

| Virtual Labs: | |
|---|---|
| 1. Problem Solving Lab (IIIT HYDERABAD) : http://ps-iiith.vlabs.ac.in/ | |
| **List of Experiments** | |
| 1. Numerical Representation<br>2. Beauty of Numbers<br>3. More on Numbers<br>4. Factorials<br>5. String Operations | 6. Recursion<br>7. Advanced Arithmetic<br>8. Searching and Sorting<br>9. Permutation<br>10.Sequences |
| 2. Computer Programming Lab (IIIT HYDERABAD) : http://cse02-iiith.vlabs.ac.in/ | |
| **List of Experiments** | |
| 1. Numerical Approximation<br>2. Functions<br>3. Advanced Control Flow<br>4. Arrays<br>5. Structures | 6. Basic Control Flow<br>7. Pointers<br>8. Recursion<br>9. Expression Evaluation |

**Text Book(s):**

1."How to Solve it by Computer", R.G. Dromey, 2014, Pearson.

2.Programming in C and Data Structures, J.R.Hanly, Ashok N. Kamthane and A.Ananda Rao, Pearson Education, 1st Edition, 2010.

**Reference Book(s):**

1."The C Programming Language", Brian W. Kernighan, Dennis M. Ritchie, 2nd Edition, Pearson.

2."Let us C", Yeswant Kanetkar, BPB publications

3."Pointers in C", Yeswant Kanetkar, BPB publications, 16th Edition, 2017

4.Computer Science, A Structured Programming Approach Using C by Behrouz Forouzan & Richard F. Gilberg, 3rd Edition, Cengage Learning

5.C Programming A Problem-Solving Approach, Behrouz A. Forouzan & E.V. Prasad,

6.F. Gilberg, 3rd Edition, Cengage Learning

7.Programming with C Rema Theraja, Oxford, 2018

8.Programming in C, 3rd Edition, 2015, Ashok N. Kamthane, Pearson Education

9.Programming in C, 3/e : A Practical Approach by Ajay Mittal, Pearson Publication

10.Problem Solving with C by SOMASHEKARA, M. T., GURU, D. S., MANJUNATHA, K. S., PHI Learning, 2nd Edition, 2018

11.C Programming with problem solving, J.A. Jones & K. Harrow, Dreamtech Press, 2001

12.Byron Gottfried, Schaum's Outline of Programming with C, 4th Edition, 2018, McGraw- Hill

**Web Resources:**

1. https://www.includehelp.com/c-programs/advacnce-c-examples.aspx
2. https://www.programiz.com/c-programming/examples
3. https://www.javatpoint.com/c-programs
4. https://www.w3resource.com/c-programming-exercises/
5. https://www.sanfoundry.com/simple-c-programs/
6. https://www.includehelp.com/c-programming-examples-solved-c-programs.aspx
7. http://www.c4learn.com/c-programs/tag/c-programs-typical-programs

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|---|---|---|---|---|---|---|---|---|
| I-B.Tech | Communication skills Lab (21EN1502) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 0 | 0 | 2 | 36 | 1 | 40 | 60 | 100 |
| **Pre-requisite:** English | | | | | | | | |
| **Course Outcomes**: After successful completion of the course, Student will be able to: | | | | | | | | |
| **CO 1** | **To develop knowledge, skills, and judgment** around human communication that facilitates their ability to work collaboratively with others. | | | | | | | |
| **CO 2** | **Develop their public speaking abilities** to speak both formally and informally. | | | | | | | |
| **CO 3** | **Understand the nuances of English language and skills** required for effective Participation in group activities. | | | | | | | |

| CO-PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO | | | | | | | | | | | | PSO | |
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | | | | | | | | | 2 | 3 | | | | |
| CO2 | | | | | | | | | 2 | 3 | | | | |
| CO3 | | | | | | | | | 2 | 3 | | | | |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

## TASK – 1

Ice - Breaking Activity, Introducing Oneself and Others – Role Plays - Oral Description of Pictures, Photographs, Products, and Process

**Practice-1 :** - Ice Breaking Activity, Introducing Oneself and Others.

**Practice-2 :** Role Plays

**Practice-3 :** Oral Description of Pictures, Photographs, Products, and Process

## TASK – 2

What is Debate, How to Debate, Tips for Debate, Debate Practice, Explanation of Debate Techniques, Debate Videos Presentation-Telephone Etiquette, Making an Appointment, Telephone Talk and Tips

**Practice-4:** Debate (Planned & Extempore)

**Practice-5:** Telephonic Conversation Practice

## TASK – 3

What is Group Discussion, Types of Group Discussion, Tips and Techniques for Effective Group Discussion, Group Discussion Videos Presentation

**Practice-6:** Group Discussions (Planned & Extempore)

**Practice-7 :** Group Discussions ()

## TASK – 4

Email writing - Resume Writing: Cover Letter – Structure of Resumes – Types of Resumes
**Practice-8 :** Cover Letter
**Practice-9 :** Resume Writing

## TASK – 5

Oral presentations (individual and group) through Seminars / PPTs - Importance of Body Language - Poster Presentation - Public Speaking Tips, Effective Presentation of renowned speakers.
**Practice-10 :** Public Speaking / Oral Presentations
**Practice-11 :** Presentation using PPTs
**Practice-12 :** Poster Presentation

SEMESTER II

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21CH1001 | BS | Chemistry | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21MA1003 | BS | Vector Calculus Complex Variables and Transforms | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 |
| 21ES1005 | ES | Python Programming and Data Science | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EN1001 | HS | English | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21CH1501 | BS | Chemistry Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21ES1503 | ES | Engineering Graphics | 0 | 1 | 4 | 5 | 3 | 40 | 60 | 100 |
| 21ES1508 | ES | Python Programming and Data Science Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EN1501 | HS | English Language Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | Total | **11** | **2** | **16** | **29** | **19.5** | **320** | **480** | **800** |

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|---|---|---|---|---|---|---|---|---|
| I-B.Tech | CHEMISTRY (21CH1001) | | | | | | | R2021 |
| **Semester** | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Basic concepts in chemistry, Advanced engineering materials, chemistry in day to day life, Fossil fuels

**Course Objectives:**

1. To impart technological aspects of modern chemistry and its applications.
2. Understand the chemistry behind electrochemical energy systems.
3. To train the students on the principles and applications of polymers.
4. To acquire knowledge of engineering materials and fuels.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | **Understand** the **fundamental concepts of chemistry to predict the structure and bonding of materials.(BL-2)** |
| **CO 2** | **Discuss** various kinds of **electro chemical cells.(BL-3)** |
| **CO 3** | **Compare** the **materials of various energy storage devices and emerging technologies.(BL-3)** |
| **CO 4** | **Demonstrate** the **mechanism and applications of different polymers in electronic devices.(BL-3)** |
| **CO 5** | **Explain calorific values, refining of petroleum and cracking of oils.(BL-2)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO 2 |
| CO1 | 3 | | | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | | | |
| CO3 | 3 | | | | | | 3 | | | | | | | |
| CO4 | 3 | | | | | | 3 | | | | | | | |
| CO5 | 3 | | | | | | 3 | | | | | | | |

**1: Low, 2-Medium, 3- High**

## COURSE CONTENT

| MODULE – 1 | Structure and Bonding Models | 10 Hrs |
|---|---|---|

**Structure and Bonding Models:** Dual nature of matter- De Broglie's equation, Schrodinger wave equation, Molecular orbital theory – bonding in homo and hetero nuclear diatomic molecules– energy level diagrams of $O_2$ and CO, etc. π-molecular orbital's of butadiene and benzene, calculation of bond order and magnetic properties, Crystal field theory – salient features – splitting in octahedral and tetrahedral complex.

At the end of the Module 1, student will be able to:

1. **Understand** the fundamental concepts of chemistry to predict the structure, properties and bonding of Engineering materials**.(BL-2)**
2. **Explain** the calculation of bond order of $O_2$ and Co molecules**.(BL-2)**
3. **Discuss** the magnetic behavior and colour of coordination compounds**.(BL-2)**

| MODULE -2 | Electro Chemistry | 10 Hrs |
|---|---|---|

**Electro chemistry:** Electrode potential, EMF of an electrochemical cell, Nernst equation, Electrodes – concepts, reference electrodes (standard hydrogen, Calomel electrode, and glass electrode), potentiometry- potentiometric titrations (red ox titrations), concept of conductivity, conductometric titrations (acid- base titrations). PV Cell and its applications.

At the end of the Module 2, students will be able to:

1. **Demonstrate** competency in the basic concepts of electrochemical cells. **(BL-3)**
2. **Explain** the significance of electrode potentials. **(BL-2)**
3. **List** the different types of electrodes. **(BL-1)**
4. **Differentiate** between Potentiometric and conductometric titrations. **(BL-2)**
5. **Illustrate** the construction of PV cell. **(BL-3)**

| MODULE-3 | Battery Technology | 09 Hrs |
|---|---|---|

**Battery Technology**: Introduction, classification of batteries, Important applications of batteries, Modern batteries- zinc-air, lithium cells,Li- $MnO_2$ cell, Ni-Cd cell, lead acid storage cell. Fuel cells- Introduction – classification, hydrogen - oxygen fuel cell, methanol - oxygen fuel cell, SOFC - Merits and demerits of fuel cell.

At the end of the Module 3, students will be able to:

1. **Classify** batteries into different types. **(BL-3)**
2. **Explain** the concept involved in the construction of batteries. **(BL-2)**
3. **Identify** the significance of batteries**.(BL-1)**
4. **Compare** the merits of different fuel cells. **(BL-2)**

| MODULE-4 | Polymer Chemistry | 10 Hrs |
|---|---|---|

**Polymer Chemistry:** Introduction to polymers, polymerization, types of polymerization, mechanism of polymer formation. Plastics - Thermoplastics and Thermosetting, Preparation, properties and applications of –PVC,PTFE, Bakelite, Urea- formaldehyde resin, Nylons. Natural Rubber, processing, vulcanization. Elastomers–Buna-S, Buna-N–preparation, properties and applications. Conducting polymers – poly acetylene, poly aniline, mechanism of conduction and applications.

At the end of the Module 4, students will be able to:

1. **Identify** different types of polymers. **(BL-1)**
2. **Distinguish** between thermoplastic and thermo setting resins. **(BL-2)**
3. **Explain** the preparation, properties and applications of some plastic materials. **(BL-2)**
4. **Apply** the knowledge of advanced polymers, conducting polymers for different Applications. **(BL-3)**

| MODULE-5 | Fuel Technology | 09 Hrs |
|---|---|---|

**Fuel Technology:** Introduction, Types of fuels, characteristics of good fuel, units, calorific value, HCV &LCV, Solid fuels, Analysis of coal-proximate and ultimate. Liquid Fuels: refining of petroleum, synthetic petrol preparation by Fischer- tropsch Process,Gaseous fuels;Natural gas,water gas,producer gas and coal gas.

At the end of the Module 5, students will be able to:

1. **Differentiate** petroleum, petrol, synthetic petrol and have knowledge how they are produced. **(BL-2)**
2. **Select** suitable fuels for IC engines. **(BL-1)**

| | |
|---|---|
| **3. Explain** calorific values, octane number, refining of petroleum and cracking of oils. **(BL-2)** | |
| **Total hours:** | **48 Hours** |

**Content beyond syllabus:**

1. Valency bond theory
2. Compounding of natural rubber
3. Fuel analysis and methods for preparation of synthetic petrol

**Self-Study:**

Contents to promote self-Learning:

| SNO | Module | Reference |
|---|---|---|
| 1 | Molecular orbital theory | https://www.youtube.com/watch?v=FMxuss0RXOU |
| 2 | Reference electrodes | https://www.youtube.com/watch?v=WMfXlncyMDc |
| 3 | Battreies | https://nptel.ac.in/courses/103/108/103108162/ |
| 4 | Plastics | https://www.youtube.com/watch?v=FATc12opDCA |
| 5 | Refining of petroleum | https://www.youtube.com/watch?v=INqhbIl8r4Q |

**Text Book(s):**

1. P. C. Jain & Monika Jain, *Engineering Chemistry*, Dhanpat Ray Publishing Company (P) Ltd, New Delhi, 16th edition, 2013.
2. K. N. Jayaveera, G. V. Subba Reddy and C. Ramachandraiah, *Engineering Chemistry*, McGraw Hill Publishers, New Delhi.
3. Energy scenario beyond2100,by S.Muthu Krishna Iyer.

**Reference Book(s):**

1. J. D. Lee, *Concise Inorganic Chemistry*, Oxford University Press, 5th edition 2010.
2. Skoog and West, *Principles of Instrumental Analysis*, Thomson, 6th edition, 2007.
3. Peter Atkins, Julio de Paula and James Keelar, *Atkins' Physical Chemistry*, Oxford University Press, 10th edition, 2010.

**Online Resources /Web References:**

1. https://drive.google.com/file/d/0Bz82vSA0C1xlWC11WkpsTmlwQVk/view
2. https://www.cgaspirants.com/2017/08/engineering-chemistry-by-jain-jain.html
3. https://www.pdfdrive.com/concise-inorganic-chemistry-d33405948.html
4. https://chemistry.com.pk/books/skoog-principles-of-instrumental-analysis1/
5. https://www.thermalfluidscentral.org/e-books/book-intro.php?b=39
6. file:///C:/Users/DELL/Downloads/HandbookOfInstrumentalTechniquesForAnalyticalChemistryPDFDrive.com.pdf
7. https://nptel.ac.in/courses/104/106/104106096/
8. https://youtu.be/KHh_IX1G6uA
9. https://www.youtube.com/watch?v=MfbxR9ZDs0s&feature=youtu.be
10. https://nptel.ac.in/courses/113/105/113105028/
11. https://www.youtube.com/watch?v=15MY7abeCDk

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|---|---|---|---|---|---|---|---|---|
| I-B. Tech | VECTOR CALCULUS COMPLEX VARIABLES & TRANSFORMS (21MA1003) | | | | | | | R-2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 1 | 0 | 64 | 4 | 40 | 60 | 100 |

**Pre-requisite**: inter mathematics

**Course Objectives:** This course aims to providing the knowledge for the student about on

1. To enlighten the learners in the concept of vector differentiation and integration.
2. To understand the concept the limit, continuity & differentiation of complex variable
3. To Evaluate the improper integrals by complex integration
4. To understand the concepts of Laplace transforms and Inverse Laplace transforms & its properties.
5. To understand the concepts of Fourier series, Fourier transforms and its properties.

**Course Outcomes**: After successful completion of the course, the student will able to:

| | |
|---|---|
| **CO 1** | Interpret the different operators such as gradient, curl and divergence to find out point function (L-3) |
| **CO 2** | Understand the concept the limit, continuity & differentiation of complex variable (L-3) |
| **CO 3** | Evaluate the integral by using contour integration .(L-5) |
| **CO 4** | Apply the Laplace transform to convert time domain into frequency domain & Inverse Laplac transforms techniques to solve the differential equations. (L-3) |
| **CO 5** | Develop the Fourier Series to the given periodic functions (L-3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | | | | | | | | | | | | |
| CO2 | 3 | 3 | | | | | | | | | | | | |
| CO3 | 3 | 3 | | | | | | | | | | | | |
| CO4 | 3 | 3 | | | | | | | | | | | | |
| CO5 | 3 | 3 | | | | | | | | | | | | |

1- Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Vector Calculus | Hours: 12h(9L+3T) |
|---|---|---|

Scalar and vector point functions, vector operator del, del applies to scalar point functions Gradient, del applied to vector point functions-Divergence and Curl, Line integra circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

At the end of the Module 1, students will be able to:

1. Apply del to Scalar and vector point functions (L-3)
2. Illustrate the physical interpretation of Gradient, Divergence and Curl (L-2)
3. Apply del to scalar and vector point functions. (L-3)
4. Illustrate the physical interpretation of gradient, divergence and curl. (L-2)

| MODULE -2 | Complex variables – Differentiation | Hours: 12h(9L+3T) |
|---|---|---|

Introduction to functions of complex variable-concept of Limit & continuity Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions finding harmonic conjugate-construction of analytic function by Milne Thomson method.

At the end of the Module 2, students will be able to:

1. Find the work done in moving a particle along the path over a force field (L-1)
2. Evaluate the rates of fluid flow along and across curves. (L-5)
3. Evaluation of surface areas integrals by applying Green`s theorems. (L-5)
4. Evaluation of volume integrals by applying Gauss theorems. (L-5)
5. Evaluation of line integrals by applying Stokes theorems. (L-5)

| MODULE-3 | Complex variables – Integration | Hours: 12h(9L+3T) |
|---|---|---|

Line integral-Contour integration, Cauchy's integral theorem (without proof) Cauchy Integral formula (without proof), zeros of analytic functions, singularities Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals (around unit circle semi-circle with f(z) not having poles on real axis).

At the end of the Module 3, students will be able to:

1. Understand the integration of complex functions. (L-3)
2. Apply Cauchy's integral theorem and Cauchy's integral formula. (L-3)
3. Understand singularities of complex functions. (L-3)
4. Evaluate improper integrals of complex functions using Residue theorem. (L-3)

| MODULE-4 | Laplace Transforms | Hours: 16h(12L+4T)) |
|---|---|---|

Definition-Laplace transform of standard functions-existence of Laplace Transform Inverse transform – First shifting Theorem, transforms of derivatives and integrals Unit step function– Second shifting theorem–Dirac's delta function Convolution theorem Laplace transform of Periodic function. Differentiation and integration of transform solving Initial value problems to ordinary differential equations with constant coefficients using Laplace transforms

At the end of the Module 4, students will be able to:

1. Understand the concept of Laplace transforms and find the Laplace transforms of elementary functions. (L-3)
2. Find the Laplace transforms of general functions using its properties. (L-2)
3. Understand Laplace transforms of special functions (Unit step function, Unit Impulse & Periodic). (L-3)
4. Apply Laplace transforms to solve Differential Equations. (L-3)

| MODULE-5 | Fourier Transform Fourier Series & Fourier Transforms | Hours: 12h(9L+3T) |
|---|---|---|

**Fourier Series**: Determination of Fourier coefficients (Euler's)–Dirichlet conditions for the existence of Fourier series–functions having discontinuity-Fourier series of Even and odd functions – Half-range Fourier sine and cosine expansions.

**Fourier Transform:** Fourier integral theorem (without proof)–Fourier sine and cosine integrals-complex form of Fourier integral. Fourier transform Fourier sine and cosine transforms Properties – Inverse transforms.

At the end of the Module 5, students will be able to:

1. Understand the concepts of Fourier transforms. (L-2)
2. Apply the properties of Fourier transforms to various engineering problems. (L-3)
3. Apply the concepts of Fourier transforms to Find impulse. (L-3)
4. Make use of the Fourier transforms and its inverse in practical applications of electronics engineering. (L-3)

| Total hours | 64 |
|---|---|

**Content beyond syllabus**

1. Complex Fourier series.
2. Parseval's Identity for Fourier Transforms.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Vector Differentiation & vector integration | CO1 | https://youtu.be/a19x_YG0oLg |
| 2 | Complex differentiation | CO2 | https://youtu.be/pfCwRLK29h4https://youtu.be/KHiw9Vs-aLM |
| 3 | Complex integration | CO3 | https://youtu.be/luJMl37-nsohttps://youtu.be/EDVJotmT584 |
| 4 | Laplace transform &Inverse Laplace transforms | CO4 | https://youtu.be/9NqdBXNyJPkhttps://youtu.be/0ZlThUd-yyw |
| 5 | Fourier series & Fourier transforms | CO5 | https://youtu.be/4cSZDHxyBf4 |

**Text Book(s):**

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers.
2. Ramana B.V., "Higher Engineering Mathematics", McGraw Hill Publishers.

**Reference Book(s):**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley.
2. Veerarajan T., "Engineering Mathematics", Tata McGraw-Hill.
3. N.P. Bali and Manish Goyal,"AText ook of Engineering Mathematics",Laxmi Publication

.

**Online Resources/ Web References:**

1. http://keralatechnologicaluniversity.blogspot.in/2015/06/erwin-kreyszig-advanced-engineering-mathematics-ktuebook-download.html
2. http://www.faadooengineers.com/threads/13449-Engineering-Maths-II-eBooks .
3. http://www.efunda.com/math/math_home/math.cfm
4. http://www.ocw.mit.edu/resources/#Mathematics
5. http://www.sosmath.com/
6. http://www.mathworld.wolfram.com

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B.Tech | PYTHON PROGRAMMING AND DATA SCIENCE (21ES1005) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Basics of programming Language.**

**Course Objectives:**

1. To learn about Python programming language syntax, semantics, and the runtime environment
2. To be familiarized with general computer programming concepts like conditional execution, loops & functions
3. To learn about mutable and immutable types.
4. To learn about the data science related functions in NUMPY.
5. To solve data science problems using PANDAS.

**Course Outcomes**: After successful completion of the course, Student will be able to

| | |
|---|---|
| **CO 1** | Demonstrate various **operators, data types and decision structures** in python. (BL - 3) |
| **CO 2** | Solve problems using **Functions and data structures** in Python (BL - 3) |
| **CO 3** | Implement the concept of **Files and Modules** (BL - 3) |
| **CO 4** | Implement Data Science queries using **NUMPY** module (BL - 3) |
| **CO 5** | Solve data manipulation task using **PANDAS** module (BL - 3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 1 | | | | | | | | | | | 1 | |
| CO2 | 2 | 2 | | | | | | | | | | | 2 | |
| CO3 | 2 | 1 | | | | | | | | | | | 2 | |
| CO4 | 2 | 2 | | | | | | | | | | | 1 | |
| CO5 | 2 | 2 | | | | | | | | | | | 1 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | I/O and Decision Structures | 10H |
|---|---|---|

**Input and Output**: Introduction to Python and installation, Input and Output, Comments, Variables, Operators. Type conversions, Expressions, Data types.

**Decision Structures and Boolean Logic**: if, if-else, if-elif-else Statements, Nested Decision Structures. Looping: while loop, for loop, Nested Loops.

At the end of the Module 1, students will be able to:

1. **Describe** python expressions, data types (BL-2)
2. **Perform** various Arithmetic calculations using Operators in Python(BL-3)
3. **Demonstrate** the usage of looping structures in python Language.(BL-3)

| MODULE -2 | Functions and Data structures | 10H |
|---|---|---|

**Functions:** Definition, Function Arguments, Anonymous Function, Scope of the variable and

namespacing, Recursion, Map, Filter and Reduce Functions

**Strings**, **Lists, Tuples and Dictionaries**: String Methods and Operations, Lists: Operations and Methods, Tuples: Operations and Methods, Dictionaries: Operations and Methods.

At the end of the Module 2, students will be able to:

1. **Implement Functions** to solve problems.(BL-3)
2. **Describe** various **String** handling functions in python(BL-2)
3. **Describe** the various **Lists, Tuples and Dictionaries** in python(BL-2)

| **MODULE-3** | **Files and Modules** | 10H |
|---|---|---|

**Files:** Text Files, File Operations, File Functions, Copying the Files, Two Files Merging into Single File.

**Modules:** Modules, Standard Modules, Packages.

At the end of the Module 3, students will be able to:

1. Describe the concepts of Files (BL-2).
2. Describe the importance of Modules and packages (BL-2).

| **MODULE-4** | **Introduction to Numpy** | 9H |
|---|---|---|

**Introduction to Numpy**: Fixed-Type Arrays in Python, Creating Arrays from Lists, Creating Arrays from Scratch Numpy Standard Data Types, The Basics of Numpy Arrays, Numpy Array Attributes.

**Array Indexing**: Accessing Single Elements, Array Slicing: Accessing Subarrays, Reshaping of Arrays, Array Concatenation and Splitting. Computation on Numpy Arrays: Universal Functions.

At the end of the Module 4, students will be able to:

1. Describe the concept of **Numpy** Module(BL-2)
2. Solve numerical problems related to data science using **Numpy Arrays.(BL-3)**
3. Apply **Universal Functions** for Data Science problems(BL-3)

| **MODULE-5** | **Data Manipulation with Pandas** | **9H** |
|---|---|---|

**Data Manipulation with Pandas**: Installing and Using Pandas, Introducing Pandas Objects, Pandas Series Object, Pandas DataFrame Object, Pandas Index Object, Data Indexing and Selection Data Selection in Series.

**Data Selection in DataFrame Operating on Data in Pandas Ufuncs**: Index Preservation UFuncs: Index Alignment, Operations Between DataFrame and Series, Handling Missing Data, Trade-Offs in Missing Data Conventions, Missing Data in Pandas, Operating on Null Values.

At the end of the Module 5, students will be able to:

1. Describe the concept of **Data Manipulation** (BL-2).
2. Describe the concept of **Pandas** for Data Science(BL-2)
3. Apply Ufunctions in pandas to generate **DataFrame** (BL-3)
4. Implement Pandas Module to handle **Missing Data**(BL-3)

| **Total hours:** | **48 HOURS** |
|---|---|

**Content Beyond Syllabus:**

1. Regular Expressions
2. Matplotlib

**Self-Study:**

Contents to promote self-Learning:

| S No | Module | Reference |
|---|---|---|
| 1 | I/O and Decision Structures | https://www.youtube.com/watch?v=JBc8LLW5KLQ<br>https://www.youtube.com/watch?v=PqFKRqpHrjw |
| 2 | Functions and Data structures | https://www.youtube.com/watch?v=XjfvaFnJ4zk |

| | | |
|---|---|---|
| | | https://www.youtube.com/watch?v=m9n2f9lhtrw |
| 3 | Files and Modules | https://www.youtube.com/watch?v=ixEeeNjjOJ0<br>https://www.youtube.com/watch?v=jZ5agHjNR3U |
| 4 | Introduction to Numpy | https://www.youtube.com/watch?v=8vVNq6JzGl8<br>https://www.youtube.com/watch?v=rN0TREj8G7U |
| 5 | Data Manipulation with Pandas | https://www.youtube.com/watch?v=8uK65aNfQ3I<br>https://www.youtube.com/watch?v=B42n3Pc-N2A |

**Text Books:**

1. Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage.
2. Python Data Science Hand Book, Jake Vanderplas, First Edition, Oreilly

**Reference Book(s):**

1. Introduction to Python Programming, Gowrishankar. S, Veena A, CRC Press.
2. Python Programming: A Modern Approach, Vamsi Kurama, Pearson.
3. Python for Data Analysis-Wes McKinney, 2nd-Edition, Oreilly.
4. Python Programming: A Modern Approach, Vamsi Kurama, Pearson. Braun W. J., Murdoch D. J., A First Course in Statistical Programming with R, Cambridge University Press, 2007

**Online Resources / Web Resources:**

1. www.tutorialpoint.com/Python
2. www.geeksforgeeks.org/python
3. www.programiz.com/python-programming
4. https://numpy.org
5. https://pandas.pydata.org

**NARAYANA ENGINERING COLLEGE:GUDUR**

**COURSE CONTENT**

**ENGLISH (21EN1001)**

**MODULE – I**

| I B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
|---|---|---|---|---|---|---|---|---|
| Semester | L | T | P | | C | CIE | SEE | TOTAL |
| II | 2 | 0 | 0 | 32 | 2 | 40 | 60 | 100 |

**Pre-requisite:** ENGLISH

**Course Objectives :**

After the completion of this Module 1 students are able to:

1. write the sentence of his/her own (L2)
2. understand the structure of the sentencesand usage(L2)
3. know the formation of words by using Affix(L1)
4. To distinguish main ideas from specific details and make use of contextual clues to inform meanings of un familiar words.
5. enhance the knowledge of idiomatic language and its usage(L2)

.

**Course Outcomes**: After successful completion of the course, the student will able to:

| | |
|---|---|
| **CO 1** | **Acquire** in depth knowledge on formulating appropriate sentences with Grammatical accuracy and also develop concept Word formation. (BL2) |
| **CO 2** | **Use** coherent and unified paragraphs with adequate support and detail and can write a topic sentence, support and concluding sentence. (BL2) |
| **CO 3** | **Analyze** the concepts of various real time scenarios to represent in an effective model. (BL4) |
| **CO 4** | **Understand** the grammar rules for synthesis of sentences and use pre writing strategies to plan to write dialogues, paragraphs and edit the text effectively.(BL – 2) |
| **CO 5** | **Relate** the skills and sub skillsof reading effectively and provide knowledge on the structure and format of technical writing.(BL – 2) |

At the end of the Module 2, students are able to:

1. use the sign posts and transition signals in his/her daily life (L2)
2. develop the knowledge in the use of preposition and Articles. (L2)
3. Know the use the different types of tenses in his/her conversation.(L2)
4. Improve the knowledge grammar and can be able to attain the success in competitive exams (L2)
5. attain the idea of how to write the different types of letters which can improve his/her writing skills (L2)
6. possess the knowledge of writing and formation of E mails (L2)

**MODULE-3**

**Grammar :** Active and Passive Voice – Direct & Indirect Speech – Comparison of Adjectives –Causeandeffect–VerbnounCollocations&Adjective-NounCollocations.

**Writing:**Note Making – Summarizing –Paragraph Writing – Paraphrasing:Techniques ofparaphrasing-Replacementofwordsandphrases,changeofsentencestructures.

At the end of this Module 3, students are able to:

1. Speak or write the sentences either in active form or in passive form.(L2).
2. Develop the knowledge of verbal and adjective collocations.(L2).
3. Know how to summarize paragraphs.(L2).
4. Enhance the writing skills by using the techniques of paragraph writing. (L2).

**MODULE-4**

**Grammar :** Misplaced modifiers – If Clauses – Simple,Compound,ComplexSentences – SpottingErrors.

**Writing :** Dialogue writing ( Formal & Informal ) –compareandcontrast paragraphs- Writing ofReviews:Book/ Play/Movie

At the end of the Module 4, students are able to:

1. develop the writing skills by using simple compound, complex sentences.(L2)
2. spot the error of the writing and speaking skills.(L2)
3. make conversations in formal and informal situations.(L2)
4. Write the reviews by using good writing skills.(L2)

**MODULE-5**

**Reading Skills :** Types of reading: Skimming, Scanning, Intensive & Extensive Reading – ReadingComprehension-ScrambleSentences-CompletethepassageusingcontextualcluesIdentifyingMainIdeas using Scanning – Technique Identifying Specific Ideas using Skimming Technique – Studyingthe use of graphic elements in texts to convey information, reveal trends/ patterns/ relationships, communicate processes or display complicated data.

**Writing:**Describing–ReportWriting:definition-purpose–types– structure-formalandinformalreports-stagesindevelopingreport-proposal,progressandfinalreports– examples.

After the completion of this module 5 students are able to:

1. gain the knowledge of different types of reading.(L2)
2. attain the good writing skills by using skimming and scanning.(L2)
3. enhance the idea of getting the information by using pie, cycle, tree, graph, flow charts.(L2)
4. write good reports on various incidents of her/his life.(L2)

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | **Grammar, vocabulary** | CO1 | https://www.youtube.com/watch?v=nQkwdAxF4xA https://www.youtube.com/watch?v=rl85jxktfms |
| 2 | Grammar, writing | CO2 | https://www.youtube.com/watch?v=XzkbcWh8s4w https://www.youtube.com/watch?v=t6eQAQE1F10 |

| | | | | |
|---|---|---|---|---|
| | 3 | Grammar, writing | CO3 | https://www.youtube.com/watch?v=0IFDuhdB2Hk<br>https://www.youtube.com/watch?v=yqyZwm6QDWI |
| | 4 | Grammar, writing | CO4 | https://www.youtube.com/watch?v=-ouWOpo2Uh8<br>https://www.youtube.com/watch?v=RnTpYKOLca4 |
| | 5 | Grammar, writing | CO5 | https://www.youtube.com/watch?v=yqyZwm6QDWI |
| | | | **Total hours:** | **32 hours** |

***1 TextBooks:***

1. Contemporary EnglishGrammar– StructuresandCompositionbyDavidGreen,MacMillanIndia,2014.
2. EffectiveTechnicalCommunicationbyAshraf,Mrizvi,TataMcGraw-Hill,2006.

**Reference Book(s):**

1. EnglishConversationPracticebyGrantTaylor,TataMcGrawHill,2009.
2. PracticalEnglishUsagebyMichaelSwan,OUP,4th Edition.
3. TechnicalCommunicationbyMeenakshiRaman&SangeetaSharma,OxfordUniversityPress,2009.
4. EnglishVocabularyinUseAdvancedbyMichaelMcCarthy,FelicityO'Dell,CambridgeUniversityPress,2008.
5. EnglishforTechnicalCommunicationforEngineeringStudents,AyshaVishwamohan, TataMcGraw-Hill2009.

**Online Resources:**

https://www.youtube.com/watch?v=nQkwdAxF4xA
https://www.youtube.com/watch?v=rl85jxktfms
https://www.youtube.com/watch?v=XzkbcWh8s4w
https://www.youtube.com/watch?v=t6eQAQE1F10
https://www.youtube.com/watch?v=0IFDuhdB2Hk
https://www.youtube.com/watch?v=yqyZwm6QDWI

# NARAYANA ENGINEERING COLLEGE:GUDUR

## Web Resources:

- *Grammar/Listening/Writing1-language.com*
- *http://www.5minuteenglish.com/*
- *https://www.englishpractice .com/Grammar/Vocabulary*
- *English Language LearningOnline*
- *http://www.bbc.co.uk/learningenglish/*
- *http://www.better-english.com/*
- *BBC Vocabulary Games*
- *Free Rice Vocabulary GameReading*
- *https://www.usingenglish.com/comprehension/*
- *https://www.englishclub.com/reading/short-stories.htm*

Online Dictionaries

- *Cambridge dictionary online :https://dictionary.cambridge.org/*
- *MacMillan dictionary :https://www.macmillandictionary.com/*
- *Oxford learner's dictionaries :https://www.oxfordlearnersdictionaries.com/*

| I-B.Tech | CHEMISTRY LAB (COMMON TO CSE,ECE & EEE ) (21CH1501) | | | | | | | R2021 |
|---|---|---|---|---|---|---|---|---|
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:** The objective of the laboratory sessions is to enable the learners to get hands-on experience on the principles discussed in theory sessions and to understand the applications of these concepts in engineering.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | **Determine** the cell constant and conductance of solutions |
| **CO 2** | Perform quantitative analysis using instrumental methods |
| **CO 3** | Utilize the fundamental laboratory techniques for analyses such as titrations, separation purification and Spectroscopy |
| **CO 4** | Analyze and gain experimental skill. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | | | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | | | |
| CO3 | 3 | | | | | | | | | | | | | |
| CO4 | 3 | | | | | | | | | | | | | |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | CO |
|---|---|
| **Task-1:** Estimation of Ferrous Ion by using Potassium Dichromate | |
| **Objective:**<br>1. Determine the percentage of ferrous iron in an unknown sample by redox titration with potassium dichromate solution.<br>2. The student will pre-treat the sample to obtain the iron in the reduced (+2 oxidation) state.<br>3.The student will use a solution of primary standard as the titrant | CO 3 |
| **Task-2:** Conductometric titration of Weak acid vs. Strong base | |
| **Objective:**<br>1.Perform a conduct metric titration of Weak acid with a strong base,<br>2. Determine the equivalence point of the titration by plotting titration curve using conductance values and amount of the base added during titration,<br>3. State the advantages conduct metric titrations. | CO 2 |
| **Task-3 :** Conductometric titration of strong acid vs. strong base | |
| **Objective:**<br>1.Perform a conductometric titration of strong acid with a strong base,<br>2. Determine the equivalence point of the titration by plotting titration curve using conductance values and amount of the base added during titration,<br>3. State the advantages conduct metric titrations. | CO2 |
| **Task-4 :** Determination of cell constant and conductance of solutions | |
| **Objective:**<br>1. To determine conductivity of the given water sample. by using conductivity meter<br>2. To understand the specific conductance. | CO 1 |
| **Task-5 :** Potentiometry - Determination of red-ox potentials and emfs | |
| **Objective:**<br>1. Determine the concentration of an unknown iron(II) solution. By using potentiometer | CO 3 |

| | |
|---|---|
| 2. Discuss how the potential changes with relative concentration of oxidised/reduced from,<br>3. Perform a red-ox titration of ammonium iron (II) sulphate using potassium dichromate as oxidizing agent,<br>4. Determine the equivalence point of the redox titration by plotting titration curve using potential change values and amount of oxidizing agent added during titration | |
| **Task-6 :** Determination of Strength of an acid in Pb-Acid battery | |
| **Objective:**<br>1. To determine the half –reactions involved in spontaneous oxidation –reduction reactions.<br>2. Explain the function of the lead storage and dry cell batteries …electrolysis involving two lead strips immersed in sulfuric acid. | CO 4 |
| **Task-7 :** Preparation of a Bakelite | |
| **Objective:** To prepare phenol formaldehyde resin. (Bakelite)<br>1. Understand the differences between linear and cross linked polymers.<br>2. Compare and contrast the recycling properties of linear and cross linked polymers.<br>3. Compare the combustion properties of various types of material.<br>4. Define the following terms: polymer, monomer, repeat unit, cross linking, biopolymer | CO 4 |
| **Task-8:** Determination of percentage Moisture content in a coal sample | |
| **Objective:**<br>**1.**To provide practical knowledge for developing experimental skill in using desicator to estimate moisture content in coal<br>**2.** Understand percentage of moisture in Coal sample. | CO4 |
| **Task-9:** Determination of percentage of Iron in Cement sample by colorimetry | |
| **Objective:** 1.To use spectroscopy to relate the absorbance of a colored solution to its concentration.<br>2. To prepare a Beer's Law Plot to determine the concentration of an unknown. | CO 2 |
| **Task-10:**Estimation of Copper by complexo metric method | |
| **Objective:**<br>1. Determine the percentage of Copper in an unknown sample by Complex metric titration with EDTA solution.<br>2. The student will pre-treat the sample to obtain the Copper in the reduced state**.**<br>3.The student will use a solution of primary standard as the titrant | CO 3 |

| | |
|---|---|
| **Additional Experiments:** | |
| **Task-11 :** Determination of hardness of ground water sample | |
| **Objective**<br>**1.** Determine the total hardness (total calcium and magnesium ion concentration).<br>2. Learn how to titrate with EDTA solution.<br>3.Determine permanent hardness and the temporary hardness | CO1 |
| **Task-12:** pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base | |
| **Objective:**<br>1. To perform a pH metric titration of an acidic solution of known molarity.<br>2. To graph the volume of base added vs. the pH and to determine the equivalence point<br>3. To calculate the morality of the basic solution | CO 2 |
| **Virtual Labs:**<br>1. http://vlab.amrita.edu/?sub=2&brch=190&sim=338&cnt=1<br>2. http://vlab.amrita.edu/?sub=2&brch=190&sim=339&cnt=1<br>3. http://vlab.amrita.edu/?sub=2&brch=190&sim=606&cnt=1 | |
| **Self-Study:**<br>Contents to promote self-Learning: | |

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Estimation of Ferrous Iron by Dichrometry. | CO 1 | https://www.youtube.com/watch?v=LxgZsMhuyNM |
| 2 | Colorometry | CO 1 | https://youtu.be/efIGmPWP-X8 |
| 3 | Polymer Preparation | CO 4 | https://www.youtube.com/watch?v=PSSK5VGcC_0 |

**Text Book(s):**

**1.**A Textbook of Quantitative Analysis, Arthur J. Vogel.

2. Jain & Jain. Engineering Chemistry: Dhanapathrai Publications., 2015.

3.S.S.Dara, Experiments and Calculations in Engineering Chemistry: S-Chand Publications, Revised Edition, 2008.

**Reference Book(s):**

1. S.K. Bhasin and Sudha Rani, "Laboratory Manual on Engineering Chemistry", Dhanpat Rai Publishing Company, New Delhi, 2nd edition.
2. Sunitha Rattan, "Experiments in Applied Chemistry", S.K. Kataria & Sons, New Delhi, 2nd edition.

**Web References:**

1. https://nptel.ac.in/courses/122101001/23
2. https://nptel.ac.in/courses/104103071/39

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B.Tech | ENGINEERING GRAPHICS (21ES1503) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credits | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 0 | 1 | 4 | 80 | 3 | 40 | 60 | 100 |

**Pre-Requisite:** Basic Mathematics (Geometry)

**Course Objectives:**

1. To impart skills on using drawing instruments
2. To convey exact and complete information of any physical object.
3. To Construct Engineering Curves.
4. To Learn and practice basic AutoCAD commands.
5. To Instruct the utility of drafting & modelling packages in orthographic and isometric drawings

| **Course Outcomes**: At the end of the course, student will be able to: | |
|---|---|
| **CO 1** | Define the qualities of precision and accuracy in engineering drawing. (BL-1) |
| **CO 2** | Draw engineering curves with different methods(BL-3). |
| **CO 3** | Develop the orthographic projection of points and straight lines(BL-3) |
| **CO 4** | Construct the planes and simple solids.(BL-3). |
| **CO 5** | Understand and practice basic AUTOCAD commands (BL-2) |

## COURSE CONTENT

### Part-A Manual Drawing

| **TASK– 1** | **Introduction and Conic sections** | 10 Hours |
|---|---|---|

**Introduction to Engineering graphics**: Principles of Engineering Graphics and their significance; various instruments used, drawing sheet sizes and title block, lettering, BIS conventions, types of lines and dimensioning methods.

Geometrical constructions: simple constructions, construction of Pentagon, Hexagon by general Method only.

**Conic Sections:**. Types of conics: Ellipse, Parabola and Hyperbola (Eccentricity method only),

| **TASK–-2** | **Orthographic Projections** | 10 Hours |
|---|---|---|

**Objectives and Principle of projection,** Methods of projections, Comparison between firstangle and third angle projection.

**Projections of points:** Projection of points placed in different quadrants.

**Projection of straight lines: F**undamental concepts**,** Line parallel, perpendicular and inclined to one and two reference planes placed in first quadrant only.

| **TASK–3** | **Projections of Solids** | 15 Hours |
|---|---|---|

**Projections of planes:** Projection of planes (Triangle, Square, Pentagon, Circle) parallel,Perpendicular and inclined to one and two reference planes placed in first quadrant only.

**Types of solids** ; Polyhedra, Solids of revolution,

**Projections of regular solids** (Prisms, Pyramids, Cylinders and Cone),with its axis Perpendicular to one plane and parallel to other plane, Axis inclined to one plane and parallel to other plane.

| TASK–4 | Isometric and Orthographic views | 10Hours |
|---|---|---|
| **Isometric Projections:** Principles, Isometric scale, Isometric views, Conventions, Isometric views of lines, planes, simple solids (Cube, Cylinder, and Cone), and Conversion of Isometric views to Orthographic views. | | |
| **Part B Computer Aided Drafting** | | |
| **TASK–5** | **Introduction to AutoCAD** | 17 Hours |
| Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets, arrays, dimensions. Dimensioning principles and conventional representations. | | |

| TASK–6 | Orthographic and Isometric Projections | 18 Hours |
|---|---|---|
| **Transformation of Isometric Projections into orthographic projections such as** simple solids such ascylinder, cone, square prism, pentagonal pyramid<br>Draw 3D model of mechanical components such as Stepped block, Bush bearing, | | |
| | **Total hours:** | **80 hours** |

**Text Book(s):**


1. Bhatt N.D. “Elementary Engineering Drawing”, Charotar Publishers, 2014.
2. Shah and Rana, Engineering Drawing, 2/e, Pearson Education, 2009
3. K.L.Narayana & P.Kannaiah, Engineering Drawing, 3/e, Scitech Publishers, Chennai,2012.
4. Engineering Drawing by Dr AVS Sridhar Kumar, Dr. Krishnaiah, T P Vara Prasad. ,Spectrum education, Sun techno Publications, 2019


**Reference Book(s):**


1. Engineering Drawing and Graphic Technology -International Edition, Thomas E.French, Charles J. Vierck, Robert J. Foster, McGraw-Hill, 2014
2. Venugopal.K “Engineering Drawing and Graphics”, New Age International (P)Ltd., New Delhi,2010

# NARAYANA ENGINEERING COLLEGE:GUDUR

| I-B.Tech | Python Programming and Data Science Lab (21ES1508) | | | | | | R2021 |
|---|---|---|---|---|---|---|---|
| **Semester** | **Hours / Week** | | | **Total hrs** | **Credit** | **Max Marks** | |
| | **L** | **T** | **P** | | **C** | **CIE** | **SEE** | **TOTAL** |
| II | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

**Pre-requisite:** Programming Knowledge

**Course Objectives:**

1. To gain knowledge on python program basics
2. To prepare students for building programs using control statements
3. To prepare students for solving the problems involving functions and files.
4. To gain knowledge Python Numpy module to solve complex mathematical problems involving matrices.
5. To gain Knowledge of data cleaning using Pandas.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO1** | Understanding and use of python- Basic Concepts**(BL -2)** |
| **CO2** | Solve the problems using python Iterative Statements**(BL -3)** |
| **CO3** | Understand the concepts of files, modules**(BL -2)** |
| **CO4** | Solve the Numerical problems that involve Matrices **(BL -3)** |
| **CO5** | Provide solutions for data cleaning tasks**(BL-3)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 1 | 1 | 2 | | | | | | | | | | 1 | |
| **CO2** | 2 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| **CO3** | 2 | 2 | 3 | 2 | 2 | | | | | | | | 3 | 2 |
| **CO4** | 2 | 2 | 2 | 1 | 1 | | | | | | | | 3 | 2 |

1-Low, 2-Medium, 3- High

| **COURSE CONTENT** | **CO** |
|---|---|
| **Task-1 - Python Basics (4 H)** | |
| 1. Running instructions in Interactive interpreter and a Python Script<br>2. Write a program to purposefully raise Indentation Error and Correct it<br>3. Write a program to compute distance between two points taking input from the user (Pythagorean Theorem)<br>4. Write a program to convert a Binary number to Decimal number and verify if it is a Perfect number. | CO 1 |
| **Task-2 - Conditional Statements (2 H)** | |
| 1. Write a program to determine if a given string is a Palindrome or not<br>2. Write a program for Fibonacci sequence is generated by adding the previous two terms by starting with 1 and 2, the first 10 terms will be: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, | CO 1 |
| **TASK-3 - Functions (2 H)** | |
| 1. Write a function that draws a Pyramid with # symbols<br>#<br># # #<br># # # # #<br># # # # # # #<br>2. Choose any five built-in string functions of C language. Implement them on your own in Python. You should not use string related Python built-in functions. | CO 2 |
| **TASK-4 -Strings (4H)** | |

| | |
|---|---|
| 1. Write a program to use split and join methods in the string and trace a birthday with Dictionary data structure.<br>2. Write a program using map, filter and reduce functions | CO 2 |
| **TASK-5 - Lists (2H)** | |
| 1. Write program which performs the following operations on lists. Don't use built-in functions<br>a) Updating elements of a list<br>b) Concatenation of list's<br>c) Check for member in the list<br>d) Insert into the list<br>e) Sum the elements of the list<br>f) Push and pop element of list<br>g) Sorting of list<br>h) Finding biggest and smallest elements in the list<br>i) Finding common elements in the list | CO 2 |
| **TASK-6 - Files (4H)** | |
| 1. Write a program to read the file content and count the number of vowels, consonants, digits and special characters in a given file.<br>2. Write a program to perform the following operations in Files:<br>a. Copy from one file to another file<br>b. Merge two files | CO3 |
| **TASK-7 –- Introduction to Numpy (4 H)** | |
| 1. Write a NumPy program to compute the outer product of two given vectors.<br>2. Write a Numpy program to compute the determinant of a given square array. | CO 4 |
| **TASK-8 - Introduction to Numpy (2H)** | |
| 1. Write a Numpy program to calculate the difference between the maximum and the minimum values of a given array along the second axis.<br>Expected Output:<br>Original array:<br>[[ 0 1 2 3 4 5]<br>[ 6 7 8 9 10 11]]<br>Difference between the maximum and the minimum values of the said array:<br>[5 5] | CO 4 |
| **TASK-9 - Introduction to Pandas (4 H)** | |
| 1. Write a Pandas program to convert a Panda module Series to Python list and it's type.<br>2. Write a Pandas program to display most frequent value in a given series and replace everything else as 'Other' in the series | CO 5 |
| **TASK-10 - Introduction to Pandas (4 H)** | |
| 1. Write a Pandas program to identify the column(s) of a given DataFrame which have at least one missing value.<br>2. Write a Pandas program to replace NaNs with a single constant value in specified columns in a DataFrame. | CO 5 |

| | |
|---|---|
| **ADDITIONAL EXPERIMENTS** | |
| **TASK – 11 – Lists, Strings, Tuples** | |
| 1. Write a python programs on lists | |

| | |
|---|---|
| 2. Write a python program on strings<br>3. Write a python program on tuples | CO2 |
| **TASK – 12 - Pandas** | |
| 1. Write a Pandas program to interpolate the missing values using the Linear Interpolation method in a given DataFrame.<br>2. Write a Pandas program to import excel data (coalpublic2013.xlsx) into a Pandas DataFrame. | CO5 |

| **Virtual Labs** | |
|---|---|
| Python Lab (IIT Bombay) :<br>1. http://vlabs.iitb.ac.in/vlabs-dev/labs/python-basics/experimentlist.html<br>2. https://pythoninstitute.org/free-python-courses/?gclid=EAIaIQobChMI4u7Uw-mZ8wIVTR0rCh0CYw2FEAAYAiAAEgL5GPD_BwE | |
| **List of Experiments** | |
| 1. Arithmetic Operations<br>2. Built-in Functions<br>3. Loops<br>4. Data Types<br>5. Strings | 6. Classes and Objects<br>7. Built-in Modules<br>8. Constructors and Inheritance<br>9. Numpy basics.<br>10. Pandas |

**Text Book(s):**

1. Python Programming: A Modern Approach, Vamsi Kurama, Pearson, 2017
2. Learning Python, Mark Lutz, Orielly, 5th Edition, 2013

**Reference Book(s):**

1. Think Python, Allen Downey, Green Tea Press, 2nd Edition
2. Core Python Programming, W.Chun, Pearson, 2nd Edition, 2007
3. Fundamentals of Python, Kenneth A. Lambert, Cengage Learning, 1st Edition, 2015
4. R. Nageswara Rao, "Core Python Programming", 2nd edition, Dreamtech Press, 2019
5. Allen B. Downey, "Think Python", 2ndEdition, SPD/O'Reilly, 2016
6. Martin C.Brown, "The Complete Reference: Python", McGraw-Hill, 2018.
7. Michael Dawson, ―Python Programming for absolute beginners, 3rd Edition, CENGAGE Learning Publications, 2018.
8. Taming Python by Programming, Jeeva Jose,Khanna Publishing House, 1st Edition, 2018
9. Introduction to Computing and Problem Solving with Python, J. Jose, Khanna Publications, 1st Edition, 2019.
10. Guido Van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

**Web References:**

1. https://www.tutorialspoint.com/python/index.htm
2. https://www.w3schools.com/python/
3. https://www.javatpoint.com/python-tutorial
4. https://www.geeksforgeeks.org/python-programming-language/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I-B.Tech | English Language Lab (21EN1501) | | | | | | | R2021 |
| **Semester** | **Hours / Week** | | | **Total hrs** | **Credit** | **Max Marks** | | |
| | **L** | **T** | **P** | | **C** | **CIE** | **SEE** | **TOTAL** |
| II | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |
| **Course Outcomes**: After successful completion of the course, the student will be able to: | | | | | | | | |
| **CO1** | **Understand how speech sounds are used** to create meaning. Apply their knowledge of English phonetics and phonology to improve their own pronunciation. | | | | | | | |
| **CO2** | **Recognize and use pitch patterns** to signal complete and incomplete thought groups and Speak confidently and intelligibly within groups and before an audience. | | | | | | | |
| **CO3** | **Learn, practice and acquire the skills** necessary to deliver effective, presentation with clarity and enable them to prepare resume with cover letter. | | | | | | | |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO1** | **PSO2** |
| **CO1** | | | | | | | | | 2 | 3 | | | | |
| **CO2** | | | | | | | | | 3 | 2 | | | | |
| **CO3** | | | | | | | | | 3 | 3 | | | | |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

**TASK – 1**

Introduction to Phonetics: Introduction to Sounds of Speech – Vowels – Consonants.

**Practice-1:** Listening Sounds of Speech – Vowels – Consonants with a focus on pronunciation
**Practice-2:** Highlighting the sounds of Vowels and Consonants

**TASK – 2**

Syllabification: Word Stress, Rules of word stress

**Practice-3:** Practice on Intonation and Stress

**TASK – 3**

Listening Skills: Types of Listening Skills- Active listening and anticipating the speaker

**Practice-4:** Listening for Specific & General Details

**Practice-5:** Listening Comprehension

**TASK – 4**

Defining & Describing: Objects, Places and Events - Video Speech Writing- Review (Oral) (Books / Movies / Products..etc.,)

**Practice-6:** Describing: Objects and Places

**Practice-7**: Describing: Events and Process

**Practice-8:** Review (Oral) : Books / Movies / Products..etc.,

**Practice-9:** Video Speech Writing

**TASK – 5**

Reading Comprehension- Information Transfer.

**Practice-10:** Reading practice for practice of Pronunciation – understanding;

**Practice-11:** writing paragraph- graphs, flow charts, diagrams - Information Transfer

**TASK – 6**

Giving and Asking Directions - Poster Presentation

**Practice-12:** Giving and Asking Directions

SEMESTER III

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21MA1006 | BS | Probability Statistics and Numerical Methods | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1009 | ES | Data Structures and Algorithms | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1010 | ES | Electronic Devices and Circuits | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2001 | PC | DC Machines and Transformers | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2002 | PC | Electrical Circuit Analysis | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2003 | PC | Power System Architecture | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21ES1513 | ES | Data Structures and Algorithms Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21ES1514 | ES | Electronics Devices and Circuits Lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CD6001 | SC | Career competency Development I | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CC6001 | SC | Value added course/Certificate course I | 0 | 0 | 0 | 0 | 1 | 40 | 60 | 100 |
| 21MC8002-13 | MC | Mandatory course II | 2 | 0 | 0 | 2 | 0 | -- | -- | -- |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **19** | **0** | **10** | **29** | **21.5** | **400** | **600** | **1000** |

| NARAYANA ENGINEERING COLLEGE: GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B. Tech | PROBABILITY STATISTICS AND NUMERICAL METHODS | | | | | | | R-2021 |
| Semester | Hours / Week | | | Total | Credit | Max Marks | | |
| I | L | T | P | hrs | C | CIE | SEE | TOTAL |
| 20MA1006 | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite**: inter mathematics

**Course Objectives:** This course aims to providing the knowledge for the student about on

1. The theory of Probability Distributions is used to Determine the expected values and analysis the data.
2. The Statistical methods used to test the product under the specifications or not.
3. To solving an algebraic and transcendental equations by applying Various numerical methods.
4. To interpolating the values through the polynomials.
5. To evaluation of integral values through the numerical methods.
6. To solve ordinary differential equations through the numerical methods.

**Course Outcomes**: After successful completion of the course, the student will able to:

| | |
|---|---|
| **CO 1** | Apply the probability distributions in life testing, expected failures for various engineering applications. (L-3) |
| **CO 2** | Test the data by applying large samples inferential techniques. (L-4) |
| **CO 3** | Test the data by applying small samples inferential techniques. (L-4) |
| **CO 4** | solve algebraic and transcendental equations and interpolate the trend value (L-3) |
| **CO 5** | To Solve ordinary differential equations by using numerical methods (L-3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | | | | 2 | | | | | | | | |
| CO2 | 3 | 3 | 2 | | | 2 | | | | | | | | |
| CO3 | 3 | 3 | | | | 2 | | | | | | | | |
| CO4 | 3 | 3 | 2 | | | | | | | | | | | |
| CO5 | 3 | 3 | | | | 2 | | | | | | | | |

1- Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Random Variables and Probability Distributions | Hours:10 |
|---|---|---|

Basics concepts of Probability, Random variables, Expectation–Discrete and continuous Distributions, Distribution function. Binomial, Poisson, Normal and Exponential distribution–Related properties (without proof).

At the end of the Module 1, students will be able to:

5. Apply the probability basic concepts to predict some information. (L-3)
6. Acquire the knowledge about classification of the variables (L-3)
7. To find the expected and variance values. (L-1)
8. Apply an appropriate probability distribution to the given data. (L-3)
9. find expected mean life time of the product by using normal distribution. (L-1)

| MODULE -2 | Large Sample Tests | Hours:10 |
|---|---|---|

Population and Sample - Null and Alternative hypothesis - Level of significance, Errors of sampling, Critical region, one tailed and two tailed tests, Procedure for testing of hypothesis, large sample tests for single mean, two means and single proportion, two proportions, Confidence interval for mean and proportions.

At the end of the Module 2, students will be able to:

1. Apply the testing of hypothesis techniques, to decide the product is good or bad. (L-3)
2. How much of sample size is required for testing (L-1)
3. Determine the control limits for the product. (L-3)
4. Select appropriate test statistic to analysis the data. (L-3)

| **MODULE-3** | **Small Sample Tests** | **Hours:8** |
|---|---|---|

t-test for single mean, difference of two means and paired t-test, F-test and Chi-square test one sample variance test, testing of goodness of fit and independence of attributes.

At the end of the Module 3, students will be able to:

5. Determine the product came from same company or not. (L-3)
6. Applying t-test techniques, to determine the experimentation useful or not (L-3)
7. Use the chi-square test techniques to select the appropriate distribution (L-3)
8. Applying the chi-square test to test whether the attributes are independent or not (L-3)

| **MODULE-4** | **Solution of Algebraic, Transcendental Equations & Interpolation** | **Hours:10** |
|---|---|---|

Introduction-Bisection method, Regula-falsi method, Newton Raphson method, Finite differences-Newton's forward and backward interpolation formulae – Lagrange's formulae.

At the end of the Module 4, students will be able to:

1. Solve an algebraic or transcendental equation using an appropriate numerical method. (L-3)
2. Understand the use of different operators in interpolation. (L-2)
3. Find interpolating polynomials using Newton's forward and backward formulae. (L-2)
4. Understand the theoretical and practical aspects, the use of numerical methods. (L-2)

| **MODULE-5** | **Numerical integration & Solution of ordinary differential equations** | **Hours:10** |
|---|---|---|

Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Modified Euler's Method- Runge-Kutta Method.

At the end of the Module 5, students will be able to:

5. Apply numerical differentiation and integration techniques to various engineering problems. (L-3)
6. Understand the techniques of Trapezoidal rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule and its applications (L-2)
7. Work out numerical differentiation whenever and wherever routine methods are not (L-1)
8. Apply Runge-kutta method in engineering problems (L-3)

| | **Total hours** | **48** |
|---|---|---|

**Content beyond syllabus:**

3. Analysis variance.
4. lognormal distribution.
5. regression analysis .

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Probability distribution | CO1 | https://www.youtube.com/watch?v=6x1pL9Yov1k |
| 2 | Large sample tests | CO2 | https://www.youtube.com/watch?v=80YzzIm8NK8 |
| 3 | Small sample tests | CO3 | https://www.youtube.com/watch?v=c5YTyGWpcmw |
| 4 | Solution of Algebraic and Transcendental Equations | CO4 | https://www.youtube.com/watch?v=apuEXUAntJo |
| 5 | Numerical Integration and solution of Ordinary differential equations | CO5 | https://www.youtube.com/watch?v=0rtaUUonwkU<br>https://www.youtube.com/watch?v=QugqSa3Gl-w |

**Text Book(s):**


3. Iyengar T.K.V., Krishna Gandhi B. & Others., (2013), Numerical Methods, Second Revised Edition, New Delhi, S.Chand & Co.Ltd.
4. Miller and Freund's, Probability and Statistics for Engineers, 8/e, Pearson, 2016.
5. 3. S.S. SASTRY, Introductory Methods of Numerical Analysis, 5/e, PHI learning private limited, 2012.
6. B S Grewal, Higher Engineering Mathematics, 44th Edition, New Delhi, Khanna Publications,2017.


**Reference Book(s):**


4. S. Ross, a First Course in Probability, Pearson Education India, 10th editon,2018.
5. Fundamentals of Mathematical Statistics" SC Gupta and V K Kapoor ,2016.
6. W. Feller, An Introduction to Probability Theory and its Applications, Wiley, 2019.


.

**Online Resources/ Web References:**

7. https://www.vfu.bg/en/e-Learning/Math_Soong_Fundamentals_of_ probability and statistics for engineers.pdf
8. http://www.math.ust.hk/~machas/numerical-methods.pdf
9. https://www.khanacademy.org/math/statistics-probability
10. http://www.randomservices.org/random/dist/index.html
11. https://global.oup.com/uk/orc/biosciences/maths/reed/01student/numerical_tutorials/pdf

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| II-B.Tech | DATA STRUCTURES AND ALGORITHMS (21ES1009) | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

| COURSE CONTENT | | |
|---|---|---|
| **MODULE – 1** | **Introduction to Data Structures** | **9H** |
| **Introduction:** Overview of Data Structures, Implementation of Data Structures, Algorithm Specifications, Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off, Arrays. **Searching:** Introduction, Basic Terminology, Linear Search and Binary Search Techniques and their complexities. | | |
| **MODULE – 2** | **Stacks and Queues** | **9H** |
| **Stacks:** Introduction, Representation of a Stack, Stack Operations, Applications of Stacks. **Queues:** Introduction, Representation of a Queue, Queue Operations, Various Queue Structures: Circular Queue, Double Ended Queue, Priority Queue, Applications of Queues. | | |
| **MODULE – 3** | **Linked Lists and Sorting** | **10H** |
| Introduction, Singly linked lists, Doubly Linked Lists, Circular Linked Lists, Linked Stacks and Queues, Applications of Linked Lists. **Sorting:** Introduction, Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort | | |
| **MODULE – 4** | **Trees** | **10H** |
| Introduction, Basic Terminologies, Definition and concepts, Representation of Binary Tree, operations on a Binary Tree, Binary Search Tree, Height balanced Binary Tree, B Trees. | | |
| **MODULE – 5** | **Graphs & Hashing** | **10H** |
| Graphs: Introduction, Graph Terminologies, Representation of Graphs, Graph Operations, Shortest Paths, Topological Sorting, Minimum Spanning Trees – Kruskal's and Prim's algorithms. Hashing: Introduction to Hash Table, Static Hashing, Dynamic Hashing. | | |
| | **Total hours:** | **48 hours** |

**TEXTBOOK:**

1. D. Samanta, **Classic Data Structures**, 2nd Edition, Prentice-Hall of India, Pvt. Ltd., India, 2012.
2. Ellis Horowitz and Sartaj Sahni, **Fundamentals of Data Structures in C**, 2nd Edition, Universities Press, 2008.

**REFERENCES:**

1. Data Structures A Pseudo code Approach with C, Second Edition by Richard F. Gilberg, Behrouz A. Forouzan, Cengage Learning.
2. Data Structures and Algorithms Using C++ by Ananda Rao Akepogu, Radhika Raju Palagiri, Pearson, 2010.
3. Data Structures and Algorithms Made Easy by Narasimha Karumanchi, Careermonk Publications, 2016
4. Peter Bras, "Advanced Data Structures", Cambridge University Press, 2014
5. Data Structures, RS Salaria, Khanna Publishing House, 3rd Edition, 2017
6. Data Structures through C, Yashwant Kanetkar, BPB Publications, 3rd Edition, 2019
7. Expert Data Structures with C, RB Patel, Khanna Publications, 2019

| NARAYANA ENGNEERING COLLEGE::GUDUR | | |
|---|---|---|
| ELECTRONIC DEVICES AND CIRCUITS (21ES1010) | | |
| **MODULE-1** | **SEMICONDUCTOR DIODES** | **10h** |
| Semiconductor diode: Principle and structure of PN junction diode, Open circuited PN junction diode, Energy band diagram of PN diode, Diode current equation, Volt-Ampere characteristics, Temperature dependence of Volt-Ampere characteristics, Diode capacitance. Special semiconductor devices: Principle of operation and characteristics of Varactor diode, Tunnel diode, Photo diode, LED, SCR. | | |
| | | |
| **MODULE-2** | **RECTIFIERS & FILTERS** | **10h** |
| Diode applications: P-N junction diode as a rectifier - Half wave rectifier, Full wave rectifier, Bridge rectifier, Rectifier parameters, Harmonic components in rectifier circuits, Clippers and clampers (Qualitative Treatment only) filters: Inductor filters, Capacitor filters, L- section filters, π- section filters, Bleeder resistor. | | |
| | | |
| **MODULE-3** | **BIPOLAR JUNCTION TRANSISTOR** | **9h** |
| Bipolar junction transistor: Construction, Principle of operation, Transistor current components, Transistor configurations, Transistor h-parameter model, Calculation of h-parameters from characteristics, Transistor as a switch, TRansistor as an amplifier. | | |
| | | |
| **MODULE-4** | **TRANSISTOR BIASING** | **10h** |
| Transistor Biasing: Need for biasing, Operating point, Load line analysis, Stabilization against variations in $I_{CO}$, $V_{BE}$ and β, Biasing and stabilization techniques: Fixed bias, Collector to base bias, Voltage divider bias, Bias compensation techniques, Thermal runaway, Heat sink and thermal stability. | | |
| | | |
| **MODULE-5** | **METAL OXIDE SEMICONDUCTOR FIELD-EFFECT TRANSISTOR** | **9h** |
| MOSFET: Construction of depletion mode and enhancement mode of NMOS and PMOS, Drain characteristics of MOSFET, Transfer characteristics of MOSFET, MOSFET as a switch, CMOS inverter and it's characteristics. | | |
| | | |
| **Text Book(s):** | | |
| 1. J. Milliman and C Halkias, "Integrated electronics", 2nd edition, Tata McGraw Hill, 1991. | | |
| 2. Donald A Neamen, "Electronic Circuits – analysis and design", 3rd edition, McGraw Hill (India), 2019. | | |
| **Reference Book(s):** | | |
| 1. Behzad Razavi, "Microelectronics", Second edition, Wiley, 2013. | | |
| 2. R. L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuits," 9th Edition, Pearson, 2006. | | |

| II-B.Tech | DC MACHINES AND TRANSFORMERS (21EE2001) | | | | | | | R2021 |
|---|---|---|---|---|---|---|---|---|
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the constructional features of DC machines.
2. To understand the phenomena of armature reaction and commutation.
3. To understand the characteristics and parallel operation of dc machines.
4. To understand the methods for speed control of DC motors and applications of DC motors.
5. To understand the various types of losses that occurs in DC machines and how to calculate efficiency.
6. To understand the constructional features of a single phase transformer.
7. To understand the efficiency and voltage regulation of a transformer.
8. To understand the Autotransformers Construction & Comparison with two winding transformer.
9. To suggest a suitable three phase transformer connection for a particular operation.
10. To understand the tap changing of transformers.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Study construction, different phenomena like: armature reaction, commutation in DC machines. |
| **CO 2** | Understand about different types of dc generators and significance of OCC. |
| **CO 3** | Develop mathematical relations for torque developed by dc motor and learn about speed – torque characteristics of different types of DC motor. Gain knowledge of about different testing methods of dc machines. |
| **CO 4** | Identification of physical components of single phase transformer. |
| **CO 5** | Learn difference between two windings and auto transformers.<br>Identification of three phase transformers circuits. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 2 | 2 | | 2 | | | | 1 | 1 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 2 | | 2 | | | | 1 | 1 | 2 | 1 | 2 |
| CO3 | 2 | 2 | 2 | 2 | | 2 | | | | 1 | 1 | 2 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 2 | | 2 | | | | 1 | 1 | 2 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 3 | | 2 | | | | 1 | 1 | 2 | 1 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1

Principle of Electromechanical Energy Conversion, Energy balance equation, Introduction to DC Generator, principle of operation, Construction details, Design of Armature winding, E.M.F Equation- Numerical problems. Armature Reaction- Cross Magnetizing and De-Magnetizing AT/Pole, Compensating Winding, Commutation, Reactance Voltage, Methods of Improving Commutation.

At the end of the Module 1, students will be able to:

- Able to understand the electromechanical energy conversion system
- Able to understand the construction, operation and armature windings of a DC generator
- Able to understand the Armature Reaction & Commutation

| MODULE -2 |
|---|
| Methods of Excitation – Separately Excited and Self Excited Generators, Build-Up of E.M.F - Critical Field Resistance and Critical Speed, Causes for Failure to Self Excite and Remedial Measures, Characteristics & Applications of Generators.<br>Parallel Operation of D.C shunt Generators, Series Generators-Use of Equalizer Bar and Cross Connection of Field Windings – Load Sharing. |
| At the end of the Module 2, students will be able to:<br>▪ Able to analyze the types of DC generators<br>▪ Able to analyze the characteristics of DC generators<br>▪ Able to understand the Parallel of operation of DC generators |
| **MODULE-3** |
| D.C Motor – Principle of Operation, Back Emf, Torque and power developed by armature, Types, Characteristics and Applications of dc Motors, speed control of DC motors(Armature control and Flux control methods), Necessity of starters, constructional details of 3-point and 4-point starters, Calculation of Starter Steps for D.C Shunt Motors.<br>Power stages in a dc machine, Losses – Constant & Variable Losses, Calculation of Efficiency, Condition for Maximum Efficiency & Numerical Problems. Methods of Testing - Brake Test, Swinburne's Test, Hopkinson's Test, Field's Test, Retardation Test. |
| At the end of the Module 3, students will be able to:<br>▪ Analyze the types of DC motors<br>▪ Analyze the characteristics & speed control of DC motors.<br>▪ Able to understand the calculation of starter resistance in steps.<br>▪ Analyze Power stages and types of losses in a DC machines.<br>▪ Able to understand the calculation of Efficiency in DC machines.<br>▪ Able to Analyze the testing of DC machines. |
| **MODULE-4** |
| Principle, construction and operation of single-phase transformers, EMF equation, equivalent circuit, phasor diagrams(no load and on load), losses and efficiency, voltage regulation, All Day Efficiency , Testing -open circuit, short circuit tests & Sumpner's test, separation of hysteresis and eddy current losses. Parallel operation of single-phase transformers. |
| At the end of the Module 5, students will be able to:<br>▪ Able to understand the construction & operation of transformer<br>▪ To predetermine the efficiency and voltage regulation of a transformer<br>▪ Able to understand the parallel operation of single phase transformers. |
| **MODULE-5** |
| Autotransformers-construction, principle, applications and comparison with two winding transformer. Three-phase transformer – construction, types of connection and their comparative features, Phase conversion - Scott connection, Tap-changing transformers - No-load and on-load tap changing of transformers. |
| At the end of the Module 6, students will be able to:<br>▪ Able to understand the Autotransformers<br>▪ Able to understand and analyze the phase conversions<br>▪ Analyze the tap changing of transformers |
| **Total hours: 60 hours** |

| **Term work:** |
|---|
| DC Machines- Lab & Transformers- Filed Work |

**Content beyond syllabus:**

1. Advanced Speed control techniques for DC Motors.
2. Zigzag/star and V/V connections in a 3-Phase Transformers

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | DC Machines Introduction & Constructional features | CO1 | https://nptel.ac.in/courses/108/102/108102146/ |
| 2 | DC Generator Characteristics | CO2 | https://www.youtube.com/watch?v=TaZjv_sy_jo |
| 3 | DC Motor | CO3 | https://www.youtube.com/watch?v=GQatiB-JHdI |
| 4 | Testing of DC Machines | CO4 | https://www.youtube.com/watch?v=8WCbTZPjcTE |
| 5 | Transformers | CO5 | https://nptel.ac.in/courses/108/105/108105155/ |
| 6 | Auto Transformers | CO6 | https://www.youtube.com/watch?v=lltVwhoPvh0 |

**Text Book(s):**

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2014, 3rd Reprint 2015.
3. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education,2010.

**Reference Book(s):**

1..Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2010, 16th Reprint 2015.
2.A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 2013.
3. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2004.

**Online Resources:**

1. http://175.101.102.82/moodle/
2. https://www.accessengineeringlibrary.com/
3. https://www.slideshare.net/
4. https://easyengineering.net/electrical-machinery-by-bimbhra/
5.https://books.google.co.in/books?id=dh_gDwAAQBAJ&lpg=PR1&dq=electrical%20machines%20by%20kothari%202020&pg=PR8#v=onepage&q&f=false

**Web Resources:**

1. https://electrical-engineering-portal.com/
2. https://www.electrical4u.com/
3. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Sadhya/experimentlist.html
4. https://www.engineering.com/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | Electrical Circuit Analysis (21EE2002) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To know the analysis of three phase balanced and unbalanced circuits and to measure active and reactive powers in three phase circuits.
2. Knowing how to determine the transient response of R-L, R-C, R-L-C series circuits for D.C and A.C excitations.
3. To introduce the various two-port networks parameters for a given circuit.
4. To evaluation of poles and zeros of a given transfer function.
5. To study the different types of filters

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the analysis of three phase balanced and unbalanced circuits. |
| **CO 2** | Solve the problems in DC transient response for the given circuit. |
| **CO 3** | Solve the problems in AC transient response for the given circuit. |
| **CO 4** | Analyze the given network using different two port network parameters. |
| **CO 5** | Explain about the fundamental and types of filters. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | | | | | | | | | 1 | 2 |
| CO5 | 2 | 2 | 3 | 2 | | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1

**Balanced Three phase circuits**

Three phase circuits: Phase sequence- Star and delta connection-Relation between line and phase voltages and currents in balanced systems-Analysis of balanced three phase circuits-Measurement of Active and Reactive power in balanced Three phase systems.

**Unbalanced Three phase circuits**

Analysis of Three Phase unbalanced circuits-Loop Method- Application of Millman's Theorem-Star Delta Transformation Technique – Two Wattmeter Method of measurement of three phase power, Advantages of Three Phase System.

At the end of the Module 1, students will be able to:

1. Explain about advantages of 3-ϕ circuits over 1-ϕ circuits
2. Distinguish between balanced and unbalanced circuits
3. Explain the phasor relationships of voltage, current, power in star and delta connected.
4. Measure the active, reactive powers in balanced circuits
5. Understand the analysis of unbalanced circuits and power calculations

### MODULE-2

**Transient Analysis**

Transient Analysis in DC and AC circuits Transient response of R-L, R-C, R-L-C circuits for DC

| |
|---|
| excitations, Solution using differential equations and Laplace transforms. |
| At the end of the Module 2, students will be able to:<br>1. Distinguish between classical method and Laplace transform approach in analysing transient phenomenon in DC excitations<br>2. Distinguish between classical method and Laplace transform approach in analysing transient phenomenon in sinusoidal excitations |
| **MODULE-3** |
| Transient Analysis in DC and AC circuits Transient response of R-L, R-C, R-L-C circuits for AC excitations, Solution using differential equations and Laplace transforms. |
| At the end of the Module 3, students will be able to:<br>9. Distinguish between classical method and Laplace transform approach in analysing transient phenomenon in AC excitations<br>10. Distinguish between classical method and Laplace transform approach in analysing transient phenomenon in sinusoidal excitations |
| **MODULE-4** |
| Two Port Network Parameters: Impedance, Admittance, Transmission and Hybrid Parameters and their relations, reciprocity and symmetry conditions, concept of transformed network, Two Port Network parameters using Transformed Variables |
| At the end of the Module 4, students will be able to:<br>1. Understand the concept of two port network theory<br>2. Find the transmission line networks for designing the transmission lines. |
| **MODULE-5** |
| **Filters**<br>Filters – Low Pass – High Pass and Band Pass – RC, RL filters– derived filters and composite filters design – Attenuators – Network functions for one port and two port networks, pole-zeros of network functions and network stability. |
| At the end of the Module 5, students will be able to:<br>1. Understand about Filter, Classification, where they can be used, etc.<br>2. Understand about attenuators and equalizers used in electronic high frequency circuits<br>3. Understand the basic of network synthesis.<br>4. Understand the properties of network function. |

| | |
|---|---|
| **Total hours:** | **48 hours** |

**Term work:**
Must be submit at least two assignments.

**Content beyond syllabus:**
1.Locus diagram and Electro magnetism

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| | 1 | Analysis of Three Phase balanced circuits | CO1 | https://www.youtube.com/watch?v=xaeob9lTXS0 |
| | 2 | Analysis of Three Phase unbalanced circuits | CO2 | https://www.youtube.com/watch?v=xaeob9lTXS0 |
| | 3 | Transient response for RL and RC circuits | CO3 | https://www.youtube.com/watch?v=2MaPC8Iw7nc |
| | 4 | Fourier Theorem | CO4 | https://nptel.ac.in/courses/108/104/108104139/ |
| | 5 | RC, RL filters | CO5 | https://www.youtube.com/watch?v=AGyjYG88LlE |
| | 6 | basic synthesis procedure | CO6 | https://nptel.ac.in/courses/108/102/108102042/ |

**Text Book(s):**

1. William Hayt, Jack E. Kemmerly and Jamie Phillips, "Engineering Circuit Analysis", Mc Graw Hill, 9th Edition, 2019.
2. A. Chakrabarti, "Circuit Theory: Analysis & Synthesis", Dhanpat Rai & Sons, 2008.

**Reference Book(s):**

1. M.E. Van Valkenberg, "Network Analysis", 3rd Edition, Prentice Hall (India), 1980.
2. V. Del Toro, "Electrical Engineering Fundamentals", Prentice Hall International, 2009.
3. Charles K. Alexander and Matthew. N. O. Sadiku, "Fundamentals of Electric Circuits" Mc Graw Hill, 5th Edition, 2013.
4. Mahamood Nahvi and Joseph Edminister, "Electric Circuits" Schaum's Series, 6th Edition, 2013.
5. John Bird, Routledge, "Electrical Circuit Theory and Technology", Taylor & Francis, 5th Edition, 2014.
6. Sudhakar, A., Circuits and Networks, Tata McGraw
7. Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education.
8. Network Analysis and Synthesis – Umesh Sinha- Satya Prakashan Publications
9. A. Anand Kumar, Network Analysis and Synthesis, PHI publication

**Online Resources:**

1. http://www.acadmix.com/eBooks_Download
2. http://www.freetechbook.com/software-engineering-f15.html

**Web References:**

1) http://www.mathtutordvd.com/products/Engineering-Circuit-Analysis-Volume-1.cfm
2) http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-andelectronics-spring-2007/video-lectures/lecture-2/
3) http://www.facstaff.bucknell.edu/mastascu/elessonsHTML/Circuit/Circuit1.html

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | POWER SYSTEM ARCHITECTURE (21EE2003) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| **I** | 0 | 0 | 3 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Basic concepts of electrical circuits and theorems

**Course Objectives:**

1. To understand the structure, essential components and their layout in non renewable generating stations.
2. To understand the electrical power generation from renewable energy sources as sun, wind and ocean.
3. To understand the calculation of different transmission line parameters and their use.
4. To understand the various effects in transmission line.
5. To understand the modeling of transmission line.

**Course Outcomes**: On successful completion of the course, student will be able to:

| | |
|---|---|
| **CO 1** | Describe the working principle and operation of Nonrenewable generating stations. **(BL-2)** |
| **CO 2** | Discuss the working principle and operation of various Renewable energy sources. **(BL-2)** |
| **CO 3** | Analyze and compute the transmission line parameters. **(BL-4)** |
| **CO 4** | Estimate the performance of a given transmission line **(BL-5)** |
| **CO 5** | Analyze the performance of transmission lines **(BL-4)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 1 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO2 | 2 | 3 | | | | | | | | | | | 3 | 2 |
| CO3 | 3 | 2 | | | | | | | | | | | 3 | 2 |
| CO4 | 2 | 3 | 1 | | 1 | | | | | | | | 1 | 3 |
| CO5 | 3 | 3 | | | | | | | | | | | 1 | 1 |

1: Low, 2-Medium, 3- High

| MODULE – 1 | NON RENEWABLE GENERATING STATIONS | 11 hrs |
|---|---|---|

**Thermal Power plant:** Importance of electrical power generation-Sources of energy-Conventional and non-conventional sources-Block Diagram of Thermal Power Station (TPS).

**Hydro Power plant:** Merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, Classification of the plants.

**Nuclear Power plant**: Introduction, Merits and demerits, selection of site, Nuclear reaction, Nuclear fuels, Nuclear plant and layout.

| MODULE-2 | RENEWABLE GENERATING STATIONS | 9 hrs |
|---|---|---|

**Solar Power Generation**: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker, Solar PV Systems. **Wind Power Generation**: Basic principles of wind energy conversion power in the wind-Forces on bladesand thrust on turbines – Wind energy conversion – site selection considerations– types of wind energy collectors.**Bio Energy:** Biomass conversion technologies , Bio gas generation , Factors affecting bio digestion or generation of gas , Classification of bio gas plants.

| MODULE-3 | TRANSMISSION LINE PARAMETERS | 8 hrs |
|---|---|---|

Types of Conductors, Resistance For Solid Conductors – Skin Effect- Calculation of Inductance for Single Phase and Three Phase, Concept of GMR & GMD, Symmetrical and Asymmetrical Conductor Configuration with and without Transposition, Numerical Problems, Capacitance Calculations for Symmetrical and Asymmetrical Single and Three Phase, Effect of Ground on Capacitance.

| MODULE-4 | MODELING OF TRANSMISSION LINES | 10 hrs |
|---|---|---|

Classification of Transmission Lines and their equivalent circuits- Nominal-T, Nominal-π. Mathematical Solutions to Estimate Regulation and Efficiency. Evaluation of A,B,C,D Constants, Surge Impedance & its Loading , Wavelengths and Propagation , Ferranti Effect , Charging Current.

| MODULE-5 | PERFORMANCE OF TRANSMISSION LINE | 10 hrs |
|---|---|---|

**Insulators:** Types of Insulators, String Efficiency and Methods for Improvement, and numerical problem. **Corona:** Corona Phenomenon, Factors Affecting Corona, Critical and disruptive Voltages and Power Loss, Radio Interference.**Sag and Tension Calculations:** Sag and Tension Calculations with Equal and Unequal Heights of Towers,Effect of Wind and Ice on Weight of Conductor, Stringing Chart, Sag Template .

| | Total hours: | 48 hours |
|---|---|---|

**Text Book(s):**

1. Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A.Chakraborti, Dhanpat Rai & Co. Pvt. Ltd., 1999
2. Non Conventional Energy Sources by G.D. Rai, Khanna Publishers, 2000.

**Reference Book(s):**

1. Principles of power systems by V.K.Mehta,Rohith Mehta S.Chand(P), 4th Edition
2. “Generation of Electrical Energy”- by B.R Gupta-S.Chand Publications,6th Edition(Reprint 2014)
3. Electrical Power Systems for Industrial Plants, Kamalesh Das, JAICO Publishing House, 2008.
4. Electrical power systems, C.L.Wadhwa, New Age International (P) Limited, 6th Edition, 2014

**Content beyond syllabus:**

1. Betz criterion, wind energy applications.
2. Underground Cables.

**Text Book(s):**

1. Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A.Chakraborti, Dhanpat Rai & Co.Pvt. Ltd., 1999.
2. Non Conventional Energy Sources by G.D. Rai, KhannaPublishers, 2000.

**Reference Book(s):**

1. Principles of power systems by V.K.Mehta, Rohith Mehta S.Chan(P), 4th Edition.
2. "Generation of Electrical Energy" – by B.R Gupta-S.Chand Publications, 6th Edition (Reprint 2014).
3. Electrical Power Systems for Industrial plants, Kamalesh Das, JAICO Publishing House, 2008.
4. Electrical Power Systems, C.L.Wadhwa, New Age International (P) Limited, 6th Edition, 2014.

**Online Resources:**

https://www.ibef.org/industry/power-sector-india
https://www.slideshare.net/sidhu007/non-conventional-sources-of-energy-30135444
https://www.energy.gov/eere/water/types-hydropower-plants
https://www.academia.edu/34930327/Insulators

**Web Resources:**

https://www.birdvilleschools.net
https://www.learnpick.in/prime/documents/ppts/details/4866/solar-cell-technology
https://courses.engr.illinois.edu
https://vikaspedia.in/energy/energy-production/wind-energy/types-of-wind-energy-conversion-devices
https://www.learnpick.in/prime/documents/ppts/details/3777/biomass-conversion-technologies

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | DATA STRUCTURES AND ALGORITHMS LAB (21ES1513) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| **I** | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

| COURSE CONTENT | | |
|---|---|---|
| **TASK-1** | | **3H** |
| 1. Write a Program to Implement the following Searching Algorithms:<br>a)Linear Search b) Binary Search | | |
| **TASK– 2** | | **6H** |
| 1. Implement the following using arrays:<br>A. Write a Program to Implement Stack Operations<br>B. Write a Program to convert a given infix expression into its Postfix using stack.<br>2.Write a Program to evaluate the Postfix Expression using stack | | |
| **TASK-3** | | **3H** |
| 1. Write a Program to Implement Queue Operations using Arrays<br>2.Write a Program to Implement Circular Queue Operations using Arrays | | |
| **TASK-4** | | **6H** |
| 1. Write a Program to implement the operations of Singly Linked List<br>2.Write a Program to implement the operations of Doubly Linked List | | |
| **TASK-5** | | **6H** |
| 1. Write a Program to implement stack operations using linked list<br>2.Write a Program to implement the operations of Circular Singly Linked List | | |
| **TASK-6** | | **3H** |
| 1.Write a Program to Sort the set of elements:<br>a) Insertion Sort b) Quick Sort | | |
| **TASK-7** | | **3H** |
| 1. Write a Program to Sort the set of elements:<br>a)Merge Sort b) Heap Sort | | |
| **TASK-8** | | **6H** |
| 1. Write a Program to implement the following on trees<br>a) Insertion and deletion operations<br>b) Traversals<br>2.Write a Program to implement Binary Search Tree Operations. | | |
| **TASK-9** | | **6H** |
| 1. Write a Program to implement the following Graph Traversal Algorithms:<br>a) Depth first traversal b) Breadth first traversal | | |
| **TASK-10** | | **6H** |
| 1. Write a Program to implement the following Minimum Spanning Tree Algorithms:<br>a) Kruskal's Algorithm b) Prim's Algorithm | | |
| **Additional Experiments:** | | |
| 1. Write Program to Implement Fibonacci Search<br>2. Write a Program to Implement Double Ended Queue Operations by using Array<br>3.Write a Program to Implement Tree traversal Techniques<br>4.Write a Program to Implement Radix Sort | | |

| | |
|---|---|
| | **48 hours** |

## TEXTBOOK:


1. D. Samanta, "Classic Data Structures", 2nd Edition, Prentice-Hall of India, Pvt. Ltd., India, 2012.
2. Horowitz Sahni and Anderson-Freed —Fundamentals of Data Structures in C. 2nd Edition, Universities Press, 2008.


## REFERENCES:


1. Richard F. Gilberg& B. A. Forouzan —Data Structures A Pseudocode Approcah with C, Second Edition, CENGAGE Learning.
2. Ananda Rao,Data Structures and Algorithms Using C++,Akepogu, Radhika Raju Palagiri, Pearson, 2010.
3. Mark Allen Weiss, Data structure and Algorithm Analysis in C. Addison Wesley Publication. 2006.

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | ELECTRONICS DEVICES AND CIRCUITS LAB (21ES1514) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| **I** | 0 | 0 | 2 | 32 | 1 | 40 | 60 | 100 |

| **Tasks List** |
|---|
| **Task-1: PN Junction Diode** |
| **Objective:** To verify the Volt- Ampere characteristics of a PN junction diode and find static, dynamic and reverse resistances of the diode from the graphs. |
| |
| **Task-2: Zener Diode** |
| **Objective:** To design a Zener diode based voltage regulator against variations of supply and load. |
| |
| **Task-3: Half Wave Rectifier** |
| **Objective:** To design a half wave rectifier for the given specifications with and without filters and verify experimentally and draw suitable graphs. |
| |
| **Task-4: Full Wave Rectifier** |
| **Objective:** To design a full wave rectifier for the given specifications with and without filters and verify experimentally and draw suitable graphs. |
| |
| **Task-5: Common Base Configuration** |
| **Objective:** To **s**tudy and draw the input and output characteristics of BJT for common base configuration experimentally, and calculate h-parameters from the graph. |
| |
| **Task-6: Common Emitter Configuration** |
| **Objective:** To verify the input and output characteristics of BJT common emitter configuration experimentally and find h-parameters from the graph. |
| |
| **Task-7: Common Collector Configuration** |
| **Objective:** To verify the input and output characteristics of BJT common collector configuration experimentally and find h-parameters from the graph. |
| |
| **Task-8: MOSFET Characteristics** |
| **Objective:** To study and draw the Volt Ampere characteristics of MOSFET. |
| |
| **Task-9: MOSFET As Switch** |
| |

| |
|---|
| **Objective:** To study the switching characteristics. |
| |
| **Task-10: LED Characteristics** |
| **Objective:** To study the characteristics of LED. |
| |
| **Additional Experiments** |
| **Task-13: Voltage- Divider Bias Circuit Using BJT.** |
| **Objective:** To analyze and design the voltage- divider bias/self bias circuit using BJT. |
| |
| **Task-14: Clippers And Clamper Circuits** |
| **Objective:** To verify clipping and clamper circuits using PN junction diode and draw the suitable graphs. |
| |
| **Text Book(s):** |
| M. Morris Mano, M.D. Ciletti, "Digital Design", 5th edition, Pearson, 2018. |
| John F Wakely Digital Design Principles And Practices, Pearson Publication, Fourth edition |
| Z. Kohavi and N. K. Jha, "Switching and Finite Automata Theory", 3rd edition, Tata McGraw Hill, 2010. |
| **Reference Book(s):** |
| Charles H Roth (Jr), Larry L. Kinney, "Fundamentals of Logic Design", 5th edition, Cengage Learning India Edition, 2010. |
| John. M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006. |
| R. P. Jain, "Modern Digital Electronics", 4th edition, McGraw-Hill Education (India Private Limited), 2012. |

SEMESTER IV

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EN1002 | HS | Universal Human Values | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2004 | PC | AC Machines | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2005 | PC | Analog Electronic Circuits | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2006 | PC | Engineering Electromagnetics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2007 | PC | Linear Control Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open elective I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2501 | PC | DC Machines and Transformers Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2502 | PC | Electrical Circuits and Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2503 | PC | Linear Control Systems and Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21CD6002 | SC | Career competency Development II | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21IC6001 | SC | Industry Oriented Course I | 0 | 0 | 0 | 0 | 1 | 100 | -- | 100 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **18** | **0** | **14** | **32** | **24.5** | **500** | **600** | **1100** |

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|---|---|---|---|---|---|---|---|---|
| II-B.Tech | Universal Human Values (21EN1002) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| **II** | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Basic concepts of electrical circuits and theorems

**Course Objectives:**

The objective of the course is four fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

**Course Outcomes**: On successful completion of the course, student will be able to:

| | |
|---|---|
| **CO 1** | Students are expected to become more aware of themselves, and their surroundings (family, society, nature) (BL-2) |
| **CO 2** | They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. (BL-2) |
| **CO 3** | They would have better critical ability. (BL-2) |
| **CO 4** | They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). (BL-2) |
| **CO 5** | It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. (BL-3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | | | | | | | | 3 | 2 | 2 | | | | |
| CO2 | | | | | | | | 3 | 2 | 2 | | | | |
| CO3 | | | | | | | | 3 | 2 | 2 | | | | |
| CO4 | | | | | | | | 3 | 2 | 2 | | | | |
| CO5 | | | | | | | | 3 | 2 | 2 | | | | |

1: Low, 2-Medium, 3- High

**Unit 1:**

**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**

. Purpose and motivation for the course, recapitulation from Universal Human Values-I
. Self-Exploration what is it? - Experiential Validation- as the process for self-exploration
. Continuous Happiness and Prosperity- A look at basic Human Aspirations
. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence)rather than as arbitrariness in choice based on liking-disliking

**Unit 2:**
**Understanding Harmony in the Human Being - Harmony in Myself!**

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

**Unit 3:**

**Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship**

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

**Unit 4:**

**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence**

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
- Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

**Unit 5:**

**Implications of the above Holistic Understanding of Harmony on Professional Ethics**

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
- Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

**Text Book**

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

**Reference Books**

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. A. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth"
5. E. FSchumacher. "Small is Beautiful"
6. Slow is Beautiful –Cecile Andrews
7. J C Kumarappa "Economy of Permanence"
8. Pandit Sunderlal "Bharat Mein Angreji Raj"
9. Dharampal, "Rediscovering India"
10. Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule"
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland(English)
13. Gandhi - Romain Rolland (English)

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | AC MACHINES (21EE2004) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the Constructional details, principle of operation and the importance of slip in Induction motor operation
2. To understand the slip-torque characteristics and torque calculations of Induction motor
3. To understand the methods of starting and speed control of Induction motor
4. To understand the construction and principle of working of synchronous machines
5. To understand the different methods of predetermining the regulation of alternators
6. To understand the concepts and computation of load sharing among alternators in parallel.
7. To understand the performance characteristics of synchronous motors and their use as synchronous condensers for power factor improvement.
8. To understand the different types of single phase motors and special motors used in house hold appliances and control systems.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | To acquire the basic knowledge of construction, working and operation of induction motor. |
| **CO 2** | Identify different speed controlling techniques of Induction motor for the given application. |
| **CO 3** | To impart knowledge on Construction and performance of salient and non – salient type synchronous generators and determine how several alternators running in parallel share the load on the system. |
| **CO 4** | Analyze the performance characteristics of synchronous motors. |
| **CO 5** | To impart knowledge on Construction, principle of operation and performance of single phase induction motors and special machines. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 1 | | | | | | | | | | 2 | 2 |
| CO2 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO3 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO4 | 3 | 2 | 1 | | | | | | | | | | 2 | 2 |
| CO5 | 3 | 2 | 1 | | | | | | | | | | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1
### POLYPHASE INDUCTION MOTORS

Polyphase Induction Motors-Constructional Details of Cage and Wound Rotor Machines, Production of Rotating Magnetic Field, Principle of Operation, Slip, Rotor Power Input, Rotor Copper Loss and Mechanical Power Developed and Their Inter Relationship.

At the end of the Module 1, students will be able to:

- Able to Analyze Production of Rotating Magnetic Field.
- Able to understand Cage and Wound Rotor Machines.

### MODULE -2

| STARTING METHODS OF INDUCTION MOTORS |
|---|
| Torque Equation, Expressions for Torque, Torque Slip Characteristics, Load characteristics, Equivalent Circuit, Phasor Diagram, Crawling and Cogging, Circle Diagram.<br>Starting- Starting methods of squirrel cage and wound rotor induction motor. Speed Control-Various methods of speed control of squirrel cage and wound rotor induction motor. |
| At the end of the Module 2, students will be able to:<br>▪ Able to Analyze Torque Slip Characteristics<br>▪ Able to understand Starting Methods of Induction Motors |
| **MODULE-3**<br>**SYNCHRONOUS GENERATORS** |
| Principle and Constructional Features of Salient Pole and Round Rotor Machines – Armature Windings, E.M.F Equation- Armature reaction – Voltage Regulation Methods, Power Flow Equation in Alternators – Synchronizing Power and Torque – Parallel Operation and Load Sharing – Effect of Change of Excitation and Mechanical Power Input – Determination of $X_d$ and $X_q$. |
| At the end of the Module 3, students will be able to:<br>▪ Able to understand the construction and principle of operation of synchronous generators.<br>▪ Able to understand the Voltage Regulation Methods.<br>▪ Able to understand the parallel operation of synchronous generators.<br>▪ Able to understand the Sub-Transient, Transient and Steady State Reactances. |
| **MODULE-4**<br>**SYNCHRONOUS MOTORS** |
| Synchronous Motors Operation – Phasor Diagram – Power Flow Equations in Synchronous Motors- Variation of Current and Power Factor with Excitation – V and Inverted V Curves – Hunting, and Methods to Eliminate Hunting – Starting Methods of Synchronous Motor. |
| At the end of the Module 4, students will be able to:<br>▪ Able to understand the operation of synchronous motors.<br>▪ Able to understand the Starting Methods of Synchronous Motor. |
| **MODULE-5**<br>**SINGLE PHASE AND SPECIAL MOTORS** |
| Single Phase Induction Motors - Constructional Features – Double Revolving Field Theory-Cross Field Theory – Split Phase Motors – Capacitor Start and Run Motors – Shaded Pole Motor. A.C Series Motor - Universal Motor – BLDC Motors , Reluctance Motor ,Stepper Motor. |
| At the end of the Module 5, students will be able to:<br>▪ Able to understand the operation of Single Phase Induction Motors.<br>▪ Able to understand the special Electrical Machines. |
| **Total hours: 48 hours** |

**Term work:**

Synchronous machines & Induction machines- Power plants & Industrial visits.

**Content beyond syllabus:**

1. Advanced Speed Control methods for Poly phase Induction Motors.
2. Two Reaction Theory –Determination of Xd and $X_q$ (Slip Test).
3. Principle of operation and control of Brushless DC motor.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | 3-phase Induction | CO1 | https://nptel.ac.in/courses/108/102/108102146/ |

| | | | | |
|---|---|---|---|---|
| | | Motors | | |
| | 2 | Circle Diagram | CO2 | https://nptel.ac.in/courses/108/105/108105131/ |
| | 3 | Synchronous Generator | CO3 | https://www.youtube.com/watch?v=b24jORRoxEc |
| | 4 | Parallel operation of Alternators | CO4 | https://www.youtube.com/watch?v=aZR7JsH9QnM |
| | 5 | Synchronous motor | CO5 | https://www.youtube.com/watch?v=fdMIuEqh48M&list=PLPpCFgQP7QKHSJQnSwaigL89gshecycXs |
| | 6 | Single Phase Induction motors | CO6 | https://nptel.ac.in/courses/108/102/108102146/ |

**Text Book(s):**

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2010, 16th Reprint 2015.

**Reference Book(s):**

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
5. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2014, 3rd Reprint 2015.

**Online Resources:**

1. http://175.101.102.82/moodle/
2. https://www.accessengineeringlibrary.com/
3. https://www.slideshare.net/
4. https://easyengineering.net/electrical-machinery-by-bimbhra/
5.https://books.google.co.in/books?id=dh_gDwAAQBAJ&lpg=PR1&dq=electrical%20machines%20by%20kothari%202020&pg=PR8#v=onepage&q&f=false

**Web Resources:**

1. https://electrical-engineering-portal.com/
2. https://www.electrical4u.com/
3. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Sadhya/experimentlist.html
4. https://www.engineering.com/

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|---|---|---|---|---|---|---|---|---|
| II-B.Tech | ANALOG ELECTRONIC CIRCUITS (21EE2005) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

| | | |
|---|---|---|
| **MODULE-1** | **WAVE SHAPING CIRCUITS** | **10h** |
| Linear Wave Shaping: High pass and low pass RC circuits and their response for sinusoidal, Step, Pulse, Square& Ramp inputs, High pass RC network as differentiator, Low pass RC circuit as an integrator. | | |
| Non-Linear wave shaping: Diode clippers, Transistor clippers, Clipping at two independent levels. Clamping operation, Clamping circuit by considering source and diode resistances. | | |
| | | |
| **MODULE-2** | **FEEDBACK AMPLIFIERS & OSCILLATORS** | **10h** |
| Feedback amplifiers: Feedback principle and concept, Types of feedback, Feedback topologies, Characteristics of negative feedback amplifiers, Determination of input & output impedance of voltage series, Voltage shunt, Current series& current shunt configurations **.** | | |
| Oscillators: Oscillator principle, Condition for oscillations, Types of oscillators, Hartley oscillator, Colpitt's oscillator, RC-phase shift oscillator, Wein bridge oscillator. | | |
| | | |
| **MODULE-3** | **SINGLE STAGE & MULTISTAGE AMPLIFIERS** | **9h** |
| Single stage amplifiers: Transistor hybrid model, Determination of h-parameters, Generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers. Multi stage Amplifiers: Classification of amplifiers, Different coupling techniques, Cascaded amplifier, Cascode amplifier. | | |
| | | |
| **MODULE-4** | **POWER AMPLIFIERS** | **9h** |
| Classification, Series fed Class A large signal amplifier, Transformer coupled class A large signal amplifier, Amplifier distortion, Push- pull class B amplifier, Complementary symmetry class B amplifier, Push- pull class AB amplifier, Complementary symmetry class AB amplifier, Class D amplifier, Heat sink and thermal stability. | | |
| | | |
| **MODULE-5** | **OP-AMP CHARACTERISTICS** | **10h** |
| Introduction, Ideal and practical Op-amp, Op-amp characteristics – DC and AC characteristics, 741 Op-amp and its features, Modes of operation-inverting, Non-inverting, Differential. Basic applications of Op-amp, Instrumentation amplifier, Sample &hold circuits, Differentiator and integrator, Comparators, Schmitt trigger, Multi-vibrators, Introduction to voltage regulators. | | |
| | | |
| | | |

**Text Book(s):**

1. Millman, Halkias and Jit, "Electronic Devices and Circuits", 4th Edition, Mc Graw Hill Education (India) Private Ltd., 2015.
2. Donald A. Neaman, "Electronic Circuit Analysis and Design", McGraw-Hill.
3. Ramakanth A. Gayakwad, "Op-Amps & Linear Ics", 4th Edition, Pearson, 2017.

**Reference Book(s):**

1. Millman and Taub, Pulse, Digital and Switching Waveforms, 3rd edition, Tata McGraw-Hill Education, 2011.
2. J. Milliman, C. C. Halkias and Chetan Parikh, "Integrated Electronics", 2nd edition, McGraw-Hill, 2010.
3. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuits Theory" Pearson/Prentice Hall, 9th edition, 2006.

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| II-B.Tech | ENGINEERING ELECTROMAGNETICS (21EE2006) | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To review the fundamentals of the different coordinate systems, vector algebra and calculus
2. To teach the basic laws of electromagnetism
3. To learn to compute and visualize the electrostatic and magnetostatic fields for simple configurations
4. To analyse the time varying electric and magnetic fields and to understand Maxwell's equations
5. To understand the propagation of electromagnetic waves through different media

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Ability to identify appropriate coordinate systems and visualize and understand the practical significance of vector calculus |
| **CO 2** | Understanding of the basic laws of electrostatics, Ability to compute, visualize electrostatic fields along with practical applications |
| **CO 3** | Understanding of the basic laws of magnetostatics |
| **CO 4** | Ability to compute, visualize magneto static fields along with practical applications |
| **CO 5** | Understanding of Maxwell's equations in different forms and medium |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO3 | 3 | 3 | 1 | 1 | | | | | | | | | 2 | 1 |
| CO4 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO5 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1

**ELECTROSTATICS**

Vector algebra , Coordinate systems, Vector calculus- Gradient, Divergence and Curl theorems and applications, Sources and effects of electromagnetic fields, Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and its applications.

At the end of the Module 1, students will be able to:

1. Recollect the basic concepts Vectors
2. Understand the applications of Electrostatics
3. Illustrate the basic laws of Electrostatics

### MODULE -2

**ELECTRIC FIELD IN MATERIALS**

Electric potential – Electric field and equipotential plots– Electric field in free space, conductors, dielectric –Dielectric polarization – Dielectric strength – Electric fields in multiple dielectrics – Boundary conditions, capacitance, Energy density, Poisson's and Laplace's equations.

At the end of the Module 2, students will be able to:

1. understand the concept of Electric potential
2. Differentiate between conductor and dielectric in electric field

**MODULE-3**

**ELECTRO MAGNETIS**

Magnetic field intensity (H) – Biot– Savart's Law – Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – Magnetic force, Lorentz force, force between two conductors,- Boundary conditions.

At the end of the Module 3, students will be able to:

1. Understand the basic laws of Magnetostatics
2. Analyze the concept of magnetic force

**MODULE-4**

**MAGNETIC POTENTIAL**

Scalar and vector potential, Poisson's Equation, Torque, Inductances and mutual inductances of solenoid and toroid, Neumann's formula, Energy density, Numerical problems.

At the end of the Module 4, students will be able to:

5. Apply the poisson's & Laplace's equations to different problems
6. Analyze the inductance of different coil combinations

**MODULE-5**

**ELECTRODYNAMIC FIELDS**

Magnetic Circuits – Faraday's law – Transformer and motional EMF – Displacement current – Maxwell's equations (differential and integral form) – Time varying potential.

At the end of the Module 5, students will be able to:

1. Understand the Faraday's law of electromagnetic induction
2. Analyze the Maxwell's equations for static and time varying fields

**Total hours: 60 hours**

**Term work:**

Design of solenoid and thoroid.

**Content beyond syllabus:**

Electric power transmission

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Gauss's law and its applications | CO1 | https://www.youtube.com/watch?v=M0GInI0vNh8 |
| 2 | Poisson's and Laplace's equations | CO2 | https://www.youtube.com/watch?v=I-lKnLnnbY4 |

| | | | | |
|---|---|---|---|---|
| | 3 | Biot– Savart's Law | CO3 | https://www.youtube.com/watch?v=X9mYh8aG2AQ |
| | 4 | Neumann's formula | CO4 | https://www.youtube.com/watch?v=iVANETIf3cM |
| | 5 | Displacement current | CO5 | https://www.youtube.com/watch?v=77PZPBXMl1w |
| | 6 | Wave parameters; velocity, intrinsic impedance, propagation constant | CO6 | https://www.youtube.com/watch?v=z__L58oLkWc |

**Text Book(s):**

1. Mathew N. O. Sadiku, S.V.Kulkarni, 'Principles of Electromagnetics', 6th Edition, Oxford University Press, 2015, Asian Edition
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', Tata McGraw Hill ,8th Revised edition, 2014

**Reference Book(s):**

3. Bhag Singh Guru and Huseyin R. Hiziroglu "Electromagnetic field theory fundamentals",Cambridge University Press; Second Revised Edition, 2009.
4. . Ashutosh Pramanik, 'Electromagnetism – Theory and Applications', PHI Learning Private Limited, New Delhi, Second Edition-2009

3. Inan U. S. and A. S. Inan, Engineering Electromagnetics, Pearson Education, 2010.
4. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), Tata McGraw Hill, 2010

**Online Resources:**

1. http://alumni.media.mit.edu/~aggelos/papers/EM_Hayt_6th.pdf
2. https://nptel.ac.in/courses/108/106/108106073/

**Web Resources:**

1. https://www.youtube.com/watch?v=pGdr9WLto4A&list=PLl6m4jcR_DbOx6s2toprJQx1MORqPa9rG
2. https://www.youtube.com/watch?v=G5P6dInMTFg&list=PLuv3GM6-gsE3-hVNaw-YEb7EeY5XVPZdz

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | LINEAR CONTROL SYSTEMS (21EE2007) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

1. To understand the merits and demerits of open and closed loop control systems
2. To understand the mathematical modeling of Electrical and mechanical control systems
3. To understand the step response of second order control systems
4. To plot Root locus for the given system transfer function
5. To understand the stability analysis from Bode plot, polar plots
6. To understand the state space analysis

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Determine the transfer function for the given electrical or mechanical systems and also determine the transfer function of a system using block diagram reduction techniques and Mason's gain formula |
| **CO 2** | Analyze the system behaviour in time domain and step response to various dampings. |
| **CO 3** | Determine the stability of given system by applying Routh's stability criteria. |
| **CO 4** | Analyze the stability of given system by means of Bode plot and polar plot |
| **CO 5** | Determine the state model and assessment of controllability & observability from the given transfer function. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | | | | | | | | | | | | 1 |
| CO2 | 2 | 1 | | | | | | | | | | | | 1 |
| CO3 | 2 | 1 | | | | | | | | | | | | 1 |
| CO4 | 2 | 1 | 1 | | | | | | | | | | | 1 |
| CO5 | 2 | 1 | 1 | | | | | | | | | | | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**INTRODUCTION TO CONTROL SYSTEMS**

Examples & Classification of control systems, merits and demerits of Open Loop and closed loop control systems, Effects of positive and negative feedback

Mathematical modelling and transfer function of Electrical and Mechanical systems, Analogous systems. **Control System Components**: DC Servo motor, AC Servo motor , Synchro Transmitter & Receiver **Block diagrams**: Block diagram representation of control systems, Block Diagram Reduction Rules .**Signal flow graph**: Definitions, Reduction using Mason's gain formula.

At the end of the Module 1, students will be able to:

1. Identify the difference between open loop and closed loop systems
2. Understand the effect of feedback on system performance
3. Model the given electrical or mechanical control system
4. Apply the block diagram reduction to simplify the given system
5. Apply the Signal flow graph reduction to simplify the given system

| |
|---|
| 6. Derive the transfer function of Ac and DC servo motor |
| **MODULE-2**<br>**TIME RESPONSE ANALYSIS** |
| Standard test signals, Time response of first order and second order un damped, under damped, critically damped and over damped systems, Time domain specifications.<br>**Error Analysis:** Steady state Error**,** static error coefficient of type 0,1, 2 systems |
| At the end of the Module 2, students will be able to:<br>11. Identify the importance of basic test signals<br>12. Analyze the Time response of second order system with different dampings<br>13. compute steady state error for the given system for any input signal. |
| **MODULE-3**<br>**STABILITY ANALYSIS** |
| **Stability:** The concept of stability, Routh's stability criterion, limitations of Routh's stability.<br>**Root locus plot**: The root locus concept, construction of root loci, effects of adding poles and zeros to G(s)H(s) on the root loci. |
| At the end of the Module 3, students will be able to:<br>7. Understand various stability issues<br>8. Apply Routh's stability criteria to given system for stability assessment<br>9. Draw Root locus plot for the given system |
| **MODULE-4**<br>**FREQUENCY RESPONSE ANALYSIS** |
| *Introduction, Frequency domain specifications, Bode plot, polar plot, Transfer function from the Bode Diagram, Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots.*<br>**Compensation Techniques:** Lag, Lead, Lag-Lead Compensators. |
| At the end of the Module 4, students will be able to:<br>1. Understand various frequency domain specifications.<br>2. Draw the Bode plot for the given system.<br>3. Determine the stability of given system from Bode plot and polar plot |
| **MODULE-5**<br>**STATE SPACE ANLYSIS** |
| **Introduction:** Concepts of state, state variables and state model, derivation of state models from differential equations, Diagonalization.<br>**Solution of state equation:** Solving the Time invariant state Equations, State Transition Matrix and it's Properties.<br>The concepts of controllability and observability. |
| At the end of the Module 5, students will be able to:<br>1. Understand the importance of state space analysis<br>2. Find the state model for the given transfer function through various techniques.<br>3. Determine the controllability and observability of given state model. |
| **Total hours: 48 hours** |

| |
|---|
| **Term work:** Tutorials & quizzes |
| **Content beyond syllabus:**<br>1. Introduction to P,PI,PID controllers.<br>2. State space representation of Armature and Field controlled DC motor. |
| **Self-Study:**<br>Contents to promote self-Learning: |

| SNO | Topic | CO | Reference |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| | 1 | Open Loop and closed loop control systems | CO1 | https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm |
| | 2 | Block diagram rules | CO2 | https://www.tutorialspoint.com/control_systems/control_systems_block_diagram_algebra.htm |
| | 3 | Time response of second order system | CO3 | https://www.tutorialspoint.com/control_systems/control_systems_time_response_analysis.htm |
| | 4 | Routh's stability criteria | CO4 | https://www.tutorialspoint.com/control_systems/control_systems_stability_analysis.htm |
| | 5 | Frequency domain specifications | CO5 | https://www.tutorialspoint.com/control_systems/control_systems_frequency_response_analysis.htm |
| | 6 | Controllability and observability | CO6 | https://www.tutorialspoint.com/control_systems/control_systems_state_space_analysis.htm |

**Text Book(s):**

1. " Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age International Publishers, 5th edition, 2007, Reprint 2012.
2. Control Systems by A. Anand Kumar, PHI Learning pvt. Ltd., second edition

**Reference Book(s):**

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013
2. 3. Modern Control Engineering, Katsuhiko Ogata, PEARSON, 1st Impression 2015.

**Online Resources:**

1. http://www.aoengr.com/SampleBook.pdf
2. http://www.ent.mrt.ac.lk/~rohan/teaching/EN5001/Reading/DORFCH1.pdf

**Web Resources:**

1. https://nptel.ac.in/courses/107/106/107106081/
2. https://www.tutorialspoint.com/control_systems/index.htm
3. https://www.youtube.com/watch?v=XYbrgwKP_6k

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | DC MACHINES AND TRANSFORMERS LAB (21EE2501) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

1. To familiarize students about OCC and internal, external characteristics of dc shunt generator.
2. To know the performance characteristics and speed control method of dc shunt motor
3. To know how to predetermine the efficiency of dc shunt motor.
4. To find efficiency, losses and regulation of single phase transformer.
5. To know how to find motor and generator efficiency by connecting to dc shunt machines back to back
6. To familiarize students about characteristics of dc series motor

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Determine the magnetization and load characteristics of a DC shunt generator |
| **CO 2** | Describe the efficiency and performance characteristics of DC motors |
| **CO 3** | Predetermination of transformer with different loads |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 3 | 2 | 2 | | | | 3 | 2 | | 3 | 3 | 3 |
| CO2 | 2 | 3 | 3 | 1 | 2 | | | | 2 | 2 | | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 1 | 2 | | | | 2 | 2 | | 3 | 3 | 3 |

1: Low, 2-Medium, 3- High

**List of Experiments Prescribed and Conducted:**

1. Conduct an Experiment to obtain OCC Characteristics of dc Shunt generator.
2. Conduct Brake test on dc shunt motor to obtain performance characteristics.
3. Conduct speed control methods of dc shunt motor.
4. Conduct Swinburne's test on a DC Shunt machine.
5. Conduct OC and SC test on single phase transformer
6. Conduct Sumpner's test on two identical transformers
7. Conduct load test on single phase transformer
8. Conduct an Experiment to obtain internal and external characteristics of dc shunt generator.
9. Conduct an experiment from 3phase to 2 phase conversion by using Scott Connection
10. Conduct load test on dc series motor.

| **Total hours:** | **30 hours** |
|---|---|

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | ELECTRICAL CIRCUIT ANALYSIS AND SIMULATION LAB (21EE2502) | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

The objectives are to study:

1. To design electrical systems.
2. To analyze a given network by applying various Network Theorems.
3. To measure three phase Active and Reactive power.
4. To understand the locus diagrams

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Analyze the three phase circuits for identification of utilization in Power system. |
| **CO 2** | Examine the transient response of series and parallel circuits with different combinations of R, L and C by using AC / DC supply. |
| **CO 3** | Identify the various parameters to analyze the transmission and distribution system in electrical engineering. |
| **CO 4** | Model the different types of filters for understand the pass band and attenuation of the various signals. |

## CO-PO & PSO Mapping:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | | | | 2 | | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | | | 2 | 2 | | | 2 | 2 | 2 | | 2 | 2 |
| CO3 | 3 | 3 | | | | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | | 2 | 2 | | 1 | 2 | 2 | | | 2 | 2 |

1 – Low Level; 2 – Moderate Level; 3 – High Level

## List of Experiments

| |
|---|
| **TASK- 1 - Analysis of three phase circuits** |
| **Objective:**<br>To verify phase voltage and line voltage in balanced and unbalanced three phase circuits. |
| **TASK -2 Measurement of Power in three phase Star and Delta Connected loads** |
| **Objective:**<br>Measurement of active power of an 3- Φ balanced load using 1- Φ Wattmeter. |
| **TASK-3 Measurement of 3-Phase Power by Two Wattmeter Method for Unbalanced Loads** |
| **Objective:**<br>To measure the reactive power consumed by a 3 phase load using 2 wattmeter method. |
| **Task -4 Transient response of RL and RC circuit** |

| |
|---|
| **Objective:**<br>To verify the **Transient response of RL circuit and to find the time constant of RL and RC network.** |
| **TASK-5 Transient response of series and parallel RLC circuit** |
| **Objective:**<br>To verify the Transient response of series and parallel RLC circuit |
| **TASK-6 Low pass & High pass filter** |
| **Objective:**<br>To design low pass filter and to plot output verses frequency characteristics |
| **TASK-7 Z & Y parameters** |
| **Objective:**<br>To calculate and verify Z -parameters and Y- parameters of given two-port network |
| **TASK-8 Transmission and Hybrid Parameters** |
| **Objective:**<br>To calculate and verify 'ABCD' parameters and h- parameters of given two-port network |
| **TASK-9 Simulation of Transient Response of DC and AC circuits** |
| **Objective:**<br>To simulate the transient response of simple DC and AC circuits using PSpice |
| **TASK -10 Simulation of k and m- pass filters** |
| **Objective:**<br>To simulate the k and m-pass filters using PSpice. |
| **Additional Experiments:**<br>**Virtual Lab:**<br>1. Parallel RC Circuits<br>2. Parallel LC Circuits<br>3. Series RL Circuits<br>4. Series LCR Circuit<br>5. Parallel LCR Circuits |
| **Text Book(s):**<br>1. Simulation of Power Electronics Circuit, M B Patil, V Ramanarayan and V T Ranganat, Alpha Science International Ltd., 2009. |

**Reference Book(s):**

1. A Sudhakar, Shyammohan S Palli, “Circuits & Networks”, Tata McGraw- Hill, 4th Edition, 2010.

2. WillamHayt.jr, Jack E.kemmerly,Steven M.Durbin, “Engineering Circuit analysis” Tata McGraw- Hill, 8th Edition2012

3 A Chakrabarthy, “Electric Circuits”, Dhanpat Rai & Sons, 6th Edition, 2010.

4 Rudrapratap, “Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers”, Oxford University Press, 1 st Edition, 1999.

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | **LINEAR CONTROL SYSTEMS & SIMULATION LAB (21EE2503)** | | | | | | | R2021 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 0 | 0 | 3 | 48 | 1.5 | 40 | 60 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

The objectives are to study:

1.To provide practical knowledge for Time response of second order system

2. Determine of transfer functions of various systems and control of it by different Methodologies

3. The characteristics of Magnetic Amplifier, servo mechanisms which are helpful in automatic control systems

4. Determine the stability analysis of different system by using PSPICE and MATLAB

5. To study the closed loop performance for the given plant using P, PD, PI, PID Controllers.

6. The design of controllers/compensators to achieve desired specifications.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Get the knowledge of feedback control and transfer function of DC servo motor |
| **CO 2** | Model the system and able to design the controllers and compensators |
| **CO 3** | Get the knowledge about the effect of poles and zeros location for second order systems |

| CO-PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO** | | | | | | | | | | | | **PSO** | |
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 2 | | | 3 | | | | 2 | 2 | | 3 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 3 | 3 | | | | 3 | 2 | | 3 | 3 | 3 |
| **CO3** | 2 | 2 | 3 | 2 | 3 | | | | 2 | 2 | | 3 | 3 | 2 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

| |
|---|
| **Task-1:Time Response of Second Order System** |
| **Objective:**To study the response of a second order system considering a series RLC circuit. |
| **Task-2: Characteristics of Synchro pair** |
| **Objective:** To study the characteristics of synchro transmitter-Receiver pair. |
| **Task-3: Characteristics of AC Servo Motor** |
| **Objective:** To draw the characteristics of ac servo motor and to calculate parameters of motor K1 and K2 |
| **Task-4: Characteristics of DC Servo Motor** |
| **Objective: :**<br>1.To obtain the Speed Vs voltage characteristics of the DC motor<br>2.To obtain Speed Vs Torque characteristics and Ia Vs Torque Characteristics |
| **Task-5: Transfer Function of DC Machine** |
| **Objective:**<br>1.To determine the Transfer function of a given DC motor.<br>2.To determine the transfer function of a D.C. generator after determining the various constants. |
| **Task-6: Characteristics of Magnetic Amplifier** |
| **Objective:** To determine the characteristics of magnetic amplifier in three modes<br>1) Series connected magnetic amplifier<br>2) Parallel connected magnetic amplifier<br>3) Self saturated magnetic amplifier. |
| **Task-7: Lag and Lead Compensation – Magnitude and Phase Plot** |

| |
|---|
| **Objective:** To Plot Magnitude and Phase Plot |
| **Task-8: Effect of P, PD, PI, PID Controller on a Second Order System.** |
| **Objective:** To study the effect of P, PD, PI, PID controllers on a second order system. |
| **Task-9:** Temperature Controller Using PID |
| **Objective:** To study the closed loop PID control in a temperature process. |
| **Task-10: Programmable Logic Controller.** |
| **Objective:** To Study and Verification of Truth Tables of Logic Gates, Simple Boolean Expressions and Application of Speed Control of Motor |

**Any two simulation experiments are to be conducted:**

| |
|---|
| **Task-11: Linear System Analysis Using MATLAB.** |
| **Objective:** To Determine the Time domain specification and Steady state errors for given linear systems theoretically and practically |
| **Task-12: Stability Analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant System Using MATLAB** |
| **Objective:** To Plot the Root Locus, bode ,Nyquist) of a given Transfer Function using MATLAB |

**Text Book(s):**

1. Simulation of Electrical and electronics Circuits using PSPICE - by M.H Rashid, M/S PHI Publications.
2. MATLAB and its Tool Books yser's manual and - Mathworks, USA
3. I. J. Nagrath and M. Gopal, “Control Systems Engineering”5th edition, New AgeInternational (P) Limited Publishers, 2007.

SEMESTER V

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EE2008 | PC | Digital Electronics and logic design | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2009 | PC | Power Distribution and Distributed Generation | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2010 | PC | Power Electronics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open elective II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE4001-05 | PE | Professional Elective I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2504 | PC | AC Machines Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2505 | PC | Analog Electronics and Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21EE2506 | PC | Power Electronics and Simulation Lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CD6003 | SC | Career competency Development III | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CC6002 | SC | Value added course/Certificate Course II | 0 | 0 | 0 | 0 | 1 | 40 | 60 | 100 |
| 21EE7501 | PR | Internship/skill development Training I | 0 | 0 | 0 | 0 | 1.5 | 00 | 100 | 100 |
| 21MC8002-13 | MC | Mandatory course III | 2 | 0 | 0 | 2 | 0 | 00 | 00 | 00 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **16** | **0** | **13** | **29** | **21.5** | **400** | **700** | **1100** |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2008 | **Digital Electronics & Logic Design** | | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I-Semester | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |
| **Pre-requisite:** Basic knowledge on number system and algebra. | | | | | | | | |
| **Course Objectives:**<br>To study the basic concepts of number systems and binary codes.<br>To minimize Boolean expressions using map and Q-M method.<br>To design combinational and sequential circuits.<br>To familiarize Registers &counters using Flip-Flops.<br>To understand the concept of memory organization | | | | | | | | |
| **Course Outcomes**: After successful completion of the course, the student will be able to: | | | | | | | | |
| **CO 1** | Use number systems, binary codes and Boolean algebra to implement digital circuits. (BL-3) | | | | | | | |
| **CO 2** | Apply minimization techniques on Boolean expressions. (BL-3) | | | | | | | |
| **CO 3** | Design combinational circuits using logic gates. (BL-3) | | | | | | | |
| **CO 4** | Analyze synchronous sequential circuits. (BL-4) | | | | | | | |
| **CO 5** | Classify the memories & programmable logic devices. (BL-2) | | | | | | | |

| **CO-PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO** | | | | | | | | | | | | **PSO** | |
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 2 | 1 | | | | | | | | | | 1 | |
| **CO2** | 3 | 3 | 3 | 1 | | | | | | | | | 1 | |
| **CO3** | 3 | 3 | 3 | 1 | | | | | | | | | 1 | 1 |
| **CO4** | 3 | 1 | 2 | 1 | | | | | | | | | 2 | 1 |
| **CO5** | 2 | 2 | | | | | | | | | | | 1 | 1 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

| **COURSE CONTENT** | | |
|---|---|---|
| **MODULE – 1** | **NUMBER SYSTEMS & BOOLEAN ALGEBRA** | **10 h** |
| Number Systems: Introduction, Number Systems, Number base conversions, 1's and 2's Complements, BCD code, Excess -3 codes, Gray code, ASCII code, Error Detection and Correction Codes. Boolean Algebra: Basic definition, Basic theorems and properties, Boolean Functions, Canonical & Standard forms, Logic gates, implementation of Boolean functions using logic gates | | |
| At the end of the Module 1, students will be able to:<br>3. List number systems. (BL-1)<br>4. Illustrate different code conversions. (BL-2)<br>5. List Theorem's and properties of Boolean algebra (BL-1)<br>6. Explain the functionality of logic gates(BL-2) | | |
| **MODULE -2** | **SIMPLIFICATION OF BOOLEAN FUNCTIONS** | **10 h** |
| Introduction, Karnaugh map simplification, Don't care conditions, Prime Implicants, Quine-McCluskey method Simplification, NAND & NOR Implementations, Two Level Implementations. | | |
| At the end of the Module 2, students will be able to:<br>1. Apply basic laws and De Morgan's theorems to simplify Boolean expressions(BL-3)<br>2. Explain map and Q-M method to minimize Boolean expressions. (BL-2)<br>3. Implement Boolean expression using universal gates. (BL-3)<br>4. Implement Boolean expression using two level methods. (BL-3) | | |

| MODULE-3 | COMBINATIONAL CIRCUITS | 9 h |
|---|---|---|
| Introduction, Design Procedure, Adders, Sub tractor, Binary Adder-Sub tractor, BCD Adder, Binary Multiplier, Magnitude Comparator, Multiplexers, De-multiplexers, Decoders, Encoders and Code Converters. | | |
| At the end of the Module 3, students will be able to:<br>1. Design combinational logic circuits. (BL-3)<br>2. Implement Boolean expression using multiplexer. (BL-3)<br>3. Implement higher order MUX using lower order MUX.(BL-3)<br>4. Design code converters using gates. (BL-3) | | |
| **MODULE-4** | **SEQUENTIAL CIRCUITS** | **10 h** |
| Introduction, Latches, Flip-flops, Master-slave flip flops, Edge-triggered flip-flops, Flip-Flop conversions, Design of Synchronous Sequential Circuits: State Equations, State Table, State reduction, State assignment, State diagram , Mealy and Moore machine models, Registers, Shift Registers, Counters: Synchronous counters, Asynchronous counters & other counters. | | |
| At the end of the Module 4, students will be able to:<br>10. Describe behavior of latches & flip flops. (BL-2)<br>11. Analyze the flip-flop conversions(BL-3)<br>12. Analyze synchronous sequential circuits. (BL-3)<br>13. Explain the design procedure of sequential circuits(BL-2)<br>14. Design synchronous sequential circuits using state reduction & assignment process. (BL-3) | | |
| **MODULE-5** | **MEMORY &PROGRAMMABLE LOGIC DEVICES** | **9 h** |
| Introduction, Random Access Memory, Types of RAM, Memory decoding, Read Only Memory, Types of ROM, Flash memory, Programmable Logic Devices (PLDs): Basic concepts, Programmable Read Only Memory (PROM), Programmable Array Logic (PAL) and Programmable Logic Array(PLA). | | |
| At the end of the Module 6, students will be able to:<br>4. Explain PROM, PAL and PLA. (BL-2)<br>5. Compare digital logic families. (BL-2)<br>6. Illustrate the characteristics of digital IC's . (BL-2) | | |
| | **Total hours:** | **48 hours** |

**Content beyond syllabus:**

1. Representation of signed & unsigned binary numbers in digital computer
2. Binary subtraction operation using 1's and 2's complement methods in digital circuits

**Self-Study:**

Contents to promote self-Learning:

| SNO | Module | Reference |
|---|---|---|
| 1 | Number systems | https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/ |
| 2 | Simplification of Boolean functions | https://www.electrical4u.com/simplifying-boolean-expression-using-k-map/<br>https://www.electronicshub.org/k-map-karnaugh-map |
| 3 | Combinational circuits | https://www.allaboutcircuits.com/textbook/digital/ |
| 4 | Sequential Circuits | https://www.electronics-tutorials.ws/sequential/seq_1.html<br>https://technobyte.org/counters-up-down-synchronous-asynchronous/ |
| 5 | Programmable logic devices | https://www.tutorialspoint.com/digital_circuits/digital_circuits_programmable_logic_devices.htm |

**Text Book(s):**

1. M. Morris Mano, M.D. Ciletti, "Digital Design", 5th edition, Pearson, 2018.
2 John F Wakely Digital Design Principles And Practices, Pearson Publication , Fourth edition

3 Anil K. Maini, “Digital Electronics: Principles, Devices and Applications”, Willey, 2007

**Reference Book(s):**

1. Anand Kumar, Switching Theory and Logic Design, PHI,2008
2. John. M Yarbrough, “Digital Logic Applications and Design”, Thomson Learning, 2006.
3. R. P. Jain, "Modern Digital Electronics", 4th edition, McGraw Hill Education (India Private Limited), 2012.

**Online Resources / Web References:**

1. https://nptel.ac.in/courses/108/105/108105113/ (IIT- Kharagpur – digital Circuits)
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-004-computation-structures-spring-2017/c4/
3. https://nptel.ac.in/courses/106/105/106105185/(IIT- Kharagpur – Switching Circuits and Logic Design)
4. https://www.researchgate.net/publication/264005171_Digital_Electronics
5. https://www.academia.edu/37445384/Anil_K._Maini_Digital_Electronics_Principles_01.04.16.pdf
6. https://intuitionke.weebly.com/uploads/1/1/8/2/118271274/digital_principles_switching_theory.pdf
7. https://www.javatpoint.com/digital-electronics

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE2009 | POWER DISTRIBUTION & DISTRIBUTED GENERATION | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | PD&DG | TOTAL |
| I-Semester | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To illustrate the Necessity of distributed generation
2. To Understand different renewable energy sources
3. To Understand the control aspects & Power quality issues of DG's
4. To understand the structure of Electrical distribution system and various factors
5. To understand the technical issues of substations such as location, ratings & Bus bar arrangements

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | **Compare the advantages & disadvantages** of various distributed generation**.** |
| **CO 2** | **Describe various Distributed Generation systems, Micro-grid** and storage devices |
| **CO 3** | **Illustrate the Economic and control aspects** of DGs |
| **CO 4** | **Analyze the different load characteristics, distribution factors & Modelling** of distribution system. |
| **CO 5** | **Design of Distribution Feeders, Voltage Drop and power loss** in D.C Distributors. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1

**Need for Distribution Generation**

Distributed generation, features and operations, advantages and disadvantages of DG, Comparison among the DG Technologies, Non conventional and renewable energy sources. Grid Interconnection- Standards of interconnection, Recent trends in power electronic DG interconnection.

### MODULE -2

**Distribution Generation Resources**

Introduction - Solar photovoltaic (PV) systems, Photovoltaic power characteristics – Wind energy conversion systems (WECS), Biomass Power, Fuel Cells, Tidal power generation schemes, Hydro power schemes - Storage devices: Batteries Storage, ultra-capacitors, flywheels.

### MODULE-3

**Economic and control aspects of DGs**

Market facts, issues and challenges – Limitations of DGs – Voltage control techniques, Reactive power control, Harmonics, Power quality issues – Reliability of DG based systems.

### MODULE-4

| |
|---|
| **Introduction To Electrical Distribution Systems**<br>Introduction to Distribution Systems, Coincidence Factor, Contribution Factor, Relationship between the Load Factor and Loss Factor, Classification of Loads (Residential, Commercial, Agricultural and Industrial), Load Modeling and Characteristics Power Factor Improvement: Causes of Low P.F -Methods of Improving P.F |
| **MODULE-5** |
| **CLASSIFICATION & DESIGN FEATURES OF DISTRIBUTION SYSTEM**<br>Classification of Distribution Systems - Comparison of DC & AC and Under-Ground & Over -Head Distribution Systems. Voltage Drop and power loss in D.C Distributors.<br>**SUBSTATIONS AND BUSBAR ARRANGEMENT**<br>Location of Substations, Classification of Substations, Single Bus Bar, Sectionalized Single Bus Bar, Main and Transfer Bus Bar, One and Half Breaker System. |

| | |
|---|---|
| **Total hours:** | **48 hours** |

**Term work:**

Field work to EHV Substation, Wind & Solar Power plants/ Tutorials/ Quiz's

**Content beyond syllabus:**

1. Distribution Automation

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Distributed Generation | CO1 | https://www.dg.history.vt.edu/ch1/introduction.html |
| 2 | Wind Energy Conversion system | CO2 | https://www.dg.history.vt.edu/ch2/conversion.html<br>https://www.dg.history.vt.edu/ch2/storage.html |
| 3 | Reliability of DG system | CO3 | https://b-ok.asia/book/2941113/af547e |
| 4 | Distribution Systems | CO4 | **https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=5&lesson=49**<br>**https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=5&lesson=9** |
| 5 | Classification & Design of DS | CO5 | **https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=5&lesson=51**<br>**https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=5&lesson=6**<br>**https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=7&lesson=13**<br>**https://www.youtube.com/watch?v=_iz8ZkjD7z8**<br>**https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=5&lesson=50**<br>**https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=7&lesson=12**<br>**https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=7&lesson=14**<br>**https://onlinecourses.nptel.ac.in/noc18_ee15/unit?unit=5&lesson=49** |

**Text Book(s):**

1. H. Lee Willis, Walter G. Scott , 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000.
2. G. Masters, Renewable and Efficient Electric Power Systems, IEEE- John Wiley and Sons Ltd. Publishers, 2nd Edition, 2013.
3. Electric Power Distribution Engineering, Turan Gonen, CRC Press, 3rd Edition,2014.
4. Electric Power Distribution, A.S. Pabla, Tata Mc Graw Hill (India) Pvt. Ltd., 6th Edition, 2011.

**Reference Book(s):**

1. "Fundamentals of renewable energy systems "by D.Mukherjee, S.Chakrabarti, New Age International Publishers.
2. Electrical Power Distribution Systems, V. Kamaraju, Jain Book Depot. 2012.
3. Electrical Power Systems for Industrial Plants, Kamalesh Das, JAICO Publishing House, 2008.

**Online Resources:**

1. https://b-ok.asia/book/1117604/f01d10
2 https://b-ok.asia/book/2729267/f90c96

**Web Resources:**

1. https://nptel.ac.in/courses/108/102/108102047/
2.https://nptel.ac.in/courses/108/107/108107112/
3. https://www.youtube.com/watch?v=ptiaNGkuylY

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2010 | POWER ELECTRONICS | | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I-Semester | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the various applications of Power electronic devices for conversion, control and conditioning of the electrical power and to get an overview of different types of power semiconductor devices and their dynamic characteristics.
2. To understand the operation, characteristics and performance parameters of controlled rectifiers
3. To study the operation, switching techniques and basics topologies of DC-DC switching regulators
4. To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | **Describe the operation** of power semiconductor devices |
| **CO 2** | **Illustrate the construction and operation** of silicon controlled rectifier |
| **CO 3** | **Analyze the various uncontrolled rectifiers and design suitable** filter circuits |
| **CO 4** | **Demonstrate** the operation of the DC-DC converters and inverters |
| **CO 5** | **Summarise the operation** of AC controllers. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO2 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO3 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO4 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO5 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**Power Semiconductor Devices**
Concept of power electronics, application of power electronics, advantages and disadvantages ofpower electronics converters, power diodes, power transistors, power MOSFETS, IGBT and GTO, uncontrolled converters.

**MODULE -2**

**Silicon Controlled Rectifier:**
Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications of SCR. Two transistor model of SCR, SCR turn on methods, switching characteristics, ratings, gate triggering circuits, different commutation techniques of SCR.

**MODULE-3**

**Phase controlled converters:**
Principle of operation of single phase and three phase half wave, half controlled, fullcontrolled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters.

| MODULE-4 | |
|---|---|
| **DC-DC converters and Inverters**<br>Principle of operation, control strategies, step down & step up choppers, types of choppers circuits based on quadrant of operation & commutation technique, Definition, classification of inverters based on nature of input source, wave shape of output voltage, Principle of operation ofsingle phase and three phase bridge inverter with R and R-L loads, | |
| **MODULE-5** | |
| **AC controllers:**<br>Principle of on-off and phase control, single phase and three phase AC Voltage controllers with R and R-L loads. Principle of operation of cycloconverters, single phase to single phase step up and step down cycloconverters. | |
| **Total hours:** | **48 hours** |

**Term work:**
Report submission on Multilevel converters with MATLAB-Simulation.

**Content beyond syllabus:**

1. Three phase cycloconverters

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | IGBT | CO1 | https://www.youtube.com/watch?v=ekSbhm4l0Go |
| 2 | Commutation techniques of SCR | CO2 | https://www.youtube.com/watch?v=mf-97ZXrOz0<br>https://www.youtube.com/watch?v=h7cu27etdmg<br>https://www.youtube.com/watch?v=WX5G0RHozAs<br>https://www.youtube.com/watch?v=d4sbVc-r7I4 |
| 3 | Three phase converters | CO3 | https://www.youtube.com/watch?v=VYmd3KKfCQQ |
| 4 | Switching mode regulators | CO4 | https://www.youtube.com/watch?v=Q7cTuZIH8IA<br>https://www.youtube.com/watch?v=I0ZbC7uCe9A<br>https://www.youtube.com/watch?v=YiYQjdARZ7I |
| 5 | Resonant Pulse inverters | CO5 | https://www.youtube.com/watch?v=AISpcLLiOPA |

**Text Book(s):**
1. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata Mc Graw Hill. 2007
2. Power Electronics, M.H. Rashid, PHI, 3rd Edition
4. Power Electronics, P.S. Bhimra, Khanna Publishers, 3rd Edition.

**Reference Book(s):**
1. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall
2. Power Electronics, V.R. Moorthi, Oxford, 2005
3. Power Electronics, Mohan,Undeland & Riobbins, Wiley India
4. Element of power Electronics, Phillip T Krein, Oxford, 2007

| |
|---|
| **Online Resources:**<br>1. https://books.google.co.in/books?id=0_D6gfUHjcEC&printsec=frontcover#v=onepage&q&f=false<br>2. https://nptel.ac.in/courses/108/105/108105066/ |
| **Web Resources:**<br>1.https://www.youtube.com/watch?v=ZbvWe9xBu3Q&list=PLp6ek2hDcoND7i5-DAD9mPmYF1Wg6ROdO<br>2. https://www.youtube.com/watch?v=1Auay7ja2oY&list=PLA07ACBDE053A8229 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2504 | AC MACHINES Lab | | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I-Semester | 0 | 0 | 3 | 30 | 1.5 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To find the performance of induction motor by calculating the efficiency.
2. To find direct and quadrature axis reactances of synchronous motor.
3. To find voltage regulation by using various methods on synchronous machine
4. To determine 'v' and 'inverted v' curves of synchronous motor.
5. To find the efficiency and power factor from circle diagram byconducting no load and blocked rotor test on 3-phase induction motor.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Find the performance characteristics of the 3-phase induction motor. |
| **CO 2** | Draw the direct and quadrature axis reactance and regulation of synchronous machine. |
| **CO 3** | To Know the Equivalent Circuit Parameters of a Single Phase Induction Motor |
| **CO 4** | To know how to draw circle diagram and determine the electrical parameters by using 3-phase squirrel cage induction motor. |
| **CO 5** | Know the voltage regulation of synchronous machine by using Synchronous Impedance Method. |
| **CO 6** | Know the voltage regulation of synchronous machine by using M.M.F.Method. |
| **CO 7** | Know the voltage regulation of synchronous machine by using ZPF.Method. |
| **CO 8** | Know the voltage regulation of synchronous machine by using ASA.Method. |
| **CO 9** | To know how to draw the V and Λ curves of synchronous motor |
| **CO 10** | Know the separation of losses of the 1-phase transformer. |

TASK- 1 - Brake Test on Three Phase Induction Motor.

TASK -2 No-Load & Blocked Rotor Tests on Three Phase Induction Motor.

Task -3 Regulation of a Three Phase Alternator by using SynchronousImpedance Method & MMF Method.

TASK-4 Regulation of a Three Phase Alternator by using ZPF & ASA Method.

TASK-5 Determination of Xd and Xq of a Salient Pole Synchronous Machine
TASK-6 V and Λ curves of synchronous motor.
TASK-7 Parallel operation of synchronous Generators.
TASK-8 Equivalent Circuit of a Single Phase Induction Motor.
TASK-9 Load test on a Single Phase Induction Motor.
TASK -10 Study of induction motor starters

**Additional Experiments:**

TASK -11 Load Test On 3-Phase Ac Slip ring Induction Motor

TASK -12 Scott Connection Of Transformers

**Text Book(s):**

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.

2. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2014, 3rd Reprint 2015.

**Reference Book(s):**

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw HillEducation, 2013.

2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

# NARAYANA ENGINEERING COLLEGE:GUDUR

| 21EE2506 | Power Electronics and Simulation Lab | | | | | | | R2021 |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I-Semester | 0 | 0 | 3 | 30 | 1.5 | 40 | 60 | 100 |

**Pre-requisite: Basic of Electrical circuit**

**Course Objectives:**

The objectives are to study:

1. The characteristics of power electronic devices with gate firing circuits
2. Various forced commutation techniques
3. The operation of single-phase voltage controller, converters and Inverters circuits with R and RL loads
4. Analyze the TPS7A4901, TPS7A8300 and TPS54160 buck regulators

**List of Experiments**

TASK- 1 Single Phase AC Voltage Controller with R and RL Loads
TASK- 2 DC Jones Chopper with R and RL Loads
TASK- 3 Forced Commutation Circuits (Class A, Class B, Class C, Class D and Class E)
TASK- 4 Buck Convertor
TASK- 5 Single Phase Parallel Inverter with R and RL Loads
TASK- 6 Single Phase Series Inverter with R and RL Loads
TASK- 7 Single Phase Dual Converter with RL Loads
TASK- 8 Illumination control / Fan control using TRIAC

**NI Multisim Simulation Experiments**:

TASK- 9 Simulation of Single Phase Half Controlled Converter
TASK- 10 Simulation of Single Phase Fully Controlled Converter
TASK- 11 Simulation of PWM Inverter
TASK- 12 Simulation of Single Phase AC Voltage Controller

**Course Outcomes**:

At the end of the course, students will be able to

1. The student will analyze the characteristics of power semiconductor devices & P Spice Simulation.
2. To Perform Laboratory Experiments practically.
3. To carry out laboratory experiments on simulation & Kits.

**Text Books**

1. Muhammad H. Rashid, Introduction to PSPICE using OrCAD for Circuits and Electronics, Pearson Education, 3rd Edition, 2003.
2. Simulation of Power Electronic Circuits by M. B. Patil , M. C. Chandorkar , V. Ramanarayanan , V.T. Ranganathan.

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO 2 |
| CO1 | 3 | 2 | | | 2 | | | | 2 | 2 | | | 3 | 2 |
| CO2 | 2 | 3 | | | 2 | | | | 2 | 2 | | | 3 | 2 |
| CO3 | 3 | 3 | | | 2 | | | | 2 | 2 | | | 3 | 2 |

1: Low, 2-Medium, 3- High

## SEMESTER VI

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EE2011 | PC | Advanced Power System Analysis | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2012 | PC | Electrical Measurements and Instrumentation | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2013 | PC | Switch Gear and Protection | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open Elective III | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE4006-10 | PE | Professional Elective II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE40011-15 | PE | Professional elective III | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2507 | PC | Electrical Measurements and Instrumentation Lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21EE2508 | PC | Power Systems Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21CD6004 | SC | Career competency Development IV | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21IC6002 | SC | Industry Oriented Course II | 0 | 0 | 0 | 0 | 1 | 100 | -- | 100 |
| | | Counseling/Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **17** | **0** | **10** | **27** | **21.5** | **460** | **540** | **1000** |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2011 | ADVANCED POWER SYSTEM ANALYSIS | | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total | Credit | Max Marks | | |
| | L | T | P | hrs | C | CIE | SEE | TOTAL |
| II-Semester | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |
| **Pre-requisite: Nil** | | | | | | | | |

**Course Objectives:**

1. Discuss the power system network matrices, formation of $Y_{Bus}$ and $Z_{Bus}$
2. Calculation of power flow in a power system network using various techniques
3. Discuss the Short Circuit Analysis
4. Examine the Power system stability

| **Course Outcomes**: After successful completion of the course, the student will be able to: | |
|---|---|
| **CO 1** | Discuss the Representation of power system matrices with formation of $Y_{BUS}$ . |
| **CO 2** | Describe the Representation of power system matrices with formation of $Z_{BUS}$ . |
| **CO 3** | Apply the concepts of algorithm for the given power system network. |
| **CO 4** | Analyse the symmetrical faults and unsymmetrical faults of a power system network. |
| **CO 5** | Develop the steady State, Dynamic and Transient Stabilities for a power system. |

| **CO-PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO** | | | | | | | | | | | | **PSO** | |
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 2 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

## COURSE CONTENT

### MODULE – 1

**P.U SYSTEM AND $Y_{bus}$ FORMATION**

Per-Unit representation of Power system elements - Per-Unit equivalent reactance network of a three phase Power System - Graph Theory: Definitions, Bus Incidence Matrix, YBus formation by Direct and Singular Transformation Methods, Numerical Problems.

### MODULE -2

**Formation of $Z_{Bus}$**: Partial network, Algorithm for the Modification of $Z_{Bus}$ Matrix for addition element for the following cases: Addition of element from a new bus to reference, Addition of element from a new bus to an old bus, Addition of element between an old bus to reference and Addition of element between two old busses, Numerical Problems .

### MODULE-3

**POWER FLOW ANALYSIS**

Static load flow equations – Load flow solutions using Gauss Seidel Method: Algorithm and Flowchart. Acceleration Factor, Load flow Solution for Simple Power Systems (Max. 3-Buses): Newton Raphson Method in Polar Co-Ordinates Form: Load Flow Solution- Jacobian Elements, Algorithm and Flowchart. Decoupled and Fast Decoupled Methods.- Comparison of Different Methods

### MODULE-4

**SHORT CIRCUIT ANALYSIS**

Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors. Symmetrical Component Theory: Positive, Negative and Zero sequence components, Positive, Negative and Zero sequence Networks. Symmetrical Fault Analysis: LLLG faults with and without fault impedance, Unsymmetrical Fault Analysis: LG, LL and LLG faults with and without fault impedance, Numerical Problems.

**MODULE-5**

**STABILITY ANALYSIS**

Elementary concepts of Steady State, Dynamic and Transient Stabilities. Derivation of Swing Equation, Power Angle Curve and Determination of Steady State Stability. Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation.
Numerical methods for solution of swing equation - Methods to improve Stability.

| | |
|---|---|
| **Total hours:** | **48 hours** |

Term work:

Field work of load flow in power system

**Content beyond syllabus:**

1. knowledge of Multi machine stability in power system.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Representation of power System Network Matrices | CO1 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 2 | Load Flow Studies | CO2 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 3 | Newton Raphson Method | CO3 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 4 | Short Circuit current and MVA Calculations | CO4 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 5 | Power system Stabilities | CO5 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |

**Text Book(s):**

1. Elements of power systems analysis by W D Stevenson Jr Fourth Edition TMH International students edition
2. Modern power system analysis by D.P.Kothari and I.J.Nagrath , TMH 3rd Edition
3. Electrical power systems by C.L. Wadhwa , New age International (P) Limited

**Reference Book(s):**

1. Power System Stability by Kimbark vol - I willey Publications, Inc
2. Power system Stability and control by P. Kundur , TMH
3. A.R. Bergen and V.vittal; "Power system Analysis", Pearsib Publication

| |
|---|
| **Online Resources:** http://175.101.102.82/moodle/course/view.php?id=693<br>1.http://www.acadmix.com/eBooks_Download<br>2. https://nptel.ac.in/courses/108105067/ 3.https://nptel.ac.in/course.html |
| **Web Resources:** http://175.101.102.82/moodle/course/view.php?id=693<br>1. https://lecturenotes.in/subject/482/power-system-analysis-psa/note<br>2.https://www.youtube.com/watch?v=j44kQiphUB4&list=PL1XaeVNXKsvwkfUAGQiUuqWBswJ4VM3Ed 3.https://www.youtube.com/watch?v=-bX0k5Dlwek&list=PLgzsL8klq6DJv0G1l7ji4OI8BTXgEADfP<br>4.https://www.youtube.com/watch?v=tb3gCr9m0LU&list=PLtcRcIUOKppXWUMEVXGwwULXgzEBygOK- 5.https://www.youtube.com/watch?v=fBm1dr_gRBk&list=PL36A60B630E8C7B56<br>6. https://www.youtube.com/watch?v=NfnrupJ0BwY&list=PLfDaOYdi9aZyO2oYhr7G9DYMhoFmqS4A1 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE2012 | ELECTRICAL MEASUREMENTS AND INSTRUMENTATION | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II-Semester | 2 | 0 | 0 | 32 | 2 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. The basic principles of different types of electrical instruments for the Measurement of voltage, current, power factor, power and energy.
2. The measurement of R, L, and C parameters using bridge circuits.
3. The principles of magnetic measurements.
4. The use of Current Transformers, Potential Transformers, andPotentiometers.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | **Describe** the concepts and principles of Measuring Instruments to measure voltage and current. |
| **CO 2** | **Analyze** the working principles of single and three phase wattmeters & energy meter to measure power and energy in circuits. |
| **CO 3** | **Demonstrate** the concepts and principles of AC and DC bridges to evaluate resistance, inductance and Capacitance for AC and DC Circuits. |
| **CO 4** | **Demonstrate** the operating principles of instrument transformers and potentiometer to measure unknown voltage, Current & Resistance in circuits. |
| **CO 5** | **Identify** the physical variables to describe operating principle of the transducers. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO2 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO3 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO4 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO5 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1

**Measurement of voltage & current**

General principles of measurements –essentials of indicating instruments - deflecting, damping, controlling torques-Ammeters and voltmeters - moving coil, moving iron, constructional details, operation, Expression for deflecting & controlling torques and errors compensations- principles shunts and multipliers – extension of range.

### MODULE -2

**Measurement of Power, Energy, Power factor**

**Power meters** :Dynamometer type wattmeter –1-phase and 3-phase - LPF and UPF- wattmeter's.

**Energy meters** : Single Phase Induction Type Energy Meter – Driving and Braking Torques – Errors andCompensations. Three Phase Energy Meter.

**P.F. Meters** : Dynamometer and Moving Iron Type – 1-ph and 3-ph Meters.

### MODULE-3

| |
|---|
| **Measurement of Resistance, Inductance and Capacitance**<br>**Measurement of Resistance**: Kelvin's double bridge -Whetstone's bridge, sensitivity, limitations- loss of charge method -Megger method.<br>**Measurement of Inductance and Capacitance**: Maxwell's inductance and capacitance bridge-Hay's bridge-Anderson's bridge- Desauty's bridge -Schering bridge-weins bridge- Problems |
| **MODULE-4** |
| **Extension of Instrument Ranges**<br>**Instrument transformers**: Current Transformers and Potential Transformers – Ratio and Phase Angle Errors – Methods for Reduction of Errors.<br>**Potentiometers:** Principle and Operation of D.C. Crompton"s Potentiometer – Standardization – Measurement of unknown Resistance, Current, Voltage -AC Potentiometers: Polar and Coordinate types-Standardization – Applications. |
| **MODULE-5** |
| **TRANSDUCERS**<br>Definition and classification - common transducers for measurement of displacement, velocity, flow, liquid level, force, pressure, strain and temperature -LVDT, piezoelectric force transducer, load cell, RTD, Thermistors, thermocouple,<br>Need for instrumentation system, data acquisition system. |

| | |
|---|---|
| **Total hours:** | **32 hours** |

**Term work:**

Term work shall consist of report on substation where various measuring instruments can be observed , ,seminars and practical session based on syllabus.

**Content beyond syllabus:**

1. Miscellaneous Measuring Instruments: Maximum demand indicators

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | PMMC INSTRUMENT | CO1 | https://www.tutorialspoint.com/electronic_measuring_instruments/electronic_measuring_instruments_dc_voltmeters.htm |
| 2 | ENERGY METER | CO2 | https://circuitglobe.com/energy-meter.html |
| 3 | DC & AC BRIDGES | CO3 | https://www.tutorialspoint.com/electronic_measuring_instruments/electronic_measuring_instruments_dc_bridges.htm |
| 4 | POTENTIOMETER | CO4 | https://www.youtube.com/watch?v=i05A2sfO7Xc&list=PL227ZNwByTlTGq1atJsFst_qnEptI870O&index=33 |
| 5 | TRANSDUCERS | CO5 | https://www.tutorialspoint.com/electronic_measuring_instruments/electronic_measuring_instruments_transducers.htm |

**Text Book(s):**

1. Electrical & Electronic Measurements and Instrumentation by AK Sawhney, Dhanpat Rai & Sons Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.
2. J. B. Gupta - A course in Electronic and Electrical measurements and Instrumentation, S. K. Kataria Publication
3.Electrical Measurements & Measuring Instruments by M.L.Anand (Author)

**Reference Book(s):**

1. E. W. Golding - Electrical & Electronic Measurements & Instrumentation
2. A. D. Helfrick and W.D. Cooper- Modern Electronic Instrumentation and Meas. Techniques

**Online Resources:**

1. https://b-ok.asia/book/2563619/2f98e0
2. https://civildatas.com/download/electronic-and-electrical-measuring-instruments-machines-by-bakshi
3. https://books.google.co.in/books?id=Q6uBCgAAQBAJ&pg=PA9&lpg=PA9&dq=measurements+for+today&source=bl&ots=oXNqMKSLxk&sig=ACfU3U2cEvMiC6pSV205CRFO3WM8vC1HMQ&hl=en&sa=X&ved=2ahUKEwjNq6Lsx4_qAhXlQ3wKHaM4DZ0Q6AEwD3oECAgQAQ#v=onepage&q=measurements%20for%20today&f=false

**Web Resources:**

1. https://nptel.ac.in/courses/108/105/108105153/
2. http://www.instrumentationtoday.com/
3. https://www.youtube.com/watch?v=n1MinLtvnPY&list=PL227ZNwByTlTGq1atJsFst_qnEptI870O&index=2

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2013 | SWITCH GEAR & PROTECTION | | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | PSP | TOTAL |
| II-Semester | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

| **Pre-requisite: Nil** | |
|---|---|
| **Course Objectives:**<br>1. To Learn in detail about Switch gear Protective equipments<br>2. To Learn about the technical aspects involved in the operation of Circuit Breakers<br>3. To Learn about Basic Requirements of Protective Relays<br>4. To Learn different types Relays & Applications | |
| **Course Outcomes**: After successful completion of the course, the student will be able to: | |
| **CO 1** | **Demonstrate** the operation of different types of Circuit Breakers |
| **CO 2** | **Describe** the operation & application of various types of protective relays. |
| **CO 3** | **Compare** the different types of comparators. |
| **CO 4** | **Analyze** the various protection schemes of various power system components like alternators, transformers and bus-bars. |
| **CO 5** | **Illustrate** the various methods of over voltage protection in power systems |

| **CO-PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO** | | | | | | | | | | | | **PSO** | |
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 2 | | | | | | | | | | | 3 | 2 |
| **CO2** | 3 | 2 | | | | | | | | | | | 3 | 2 |
| **CO3** | 3 | 2 | | | | | | | | | | | 3 | 2 |
| **CO4** | 3 | 2 | | | | | | | | | | | 3 | 2 |
| **CO5** | 3 | 2 | | | | | | | | | | | 3 | 2 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

| **COURSE CONTENT** |
|---|
| **MODULE – 1** |
| **CIRCUIT BREAKERS:** Circuit Breakers: Arc Phenomenon, Methods of Arc Interruption, Restriking and Recovery Voltage - Restriking Phenomenon, RRRV, Current Chopping and Resistance Switching. Constructional features & Principle operation of Minimum Oil Circuit Breakers, Air Blast Circuit Breakers, Vacuum and SF6 Circuit Breakers, Ratings of CB's, Auto Reclosure's. |
| **MODULE-2** |
| **PROTECTIVE RELAYS:** Basic Requirements of Protective Relays-Primary and Backup Protection<br>**CLASSIFICATION OF RELAYS-I :** Types of Electromagnetic Relays, Over current Relays,Directional & Non Directional Relays |
| **MODULE-3** |
| **CLASSIFICATION OF RELAYS-II:** Differential Relays, Distance Relays, Static Relays-Advantages & Disadvantages, Microprocessor Based Relays-Advantages & Disadvantages, Universal Relay Torque equation.<br>**COMPARATORS:** Amplitude and Phase Comparators |
| **MODULE-4** |

**GENERATOR PROTECTION:** Protection of Generators against Stator Faults, Rotor Faults andAbnormal Conditions, Numerical Problems on percentage winding unprotected.

**TRANSFORMER PROTECTION:** Differential Protection, Buccholz Relay Protection, Numerical Problems on Design of CT Ratio.

**FEEDER PROTECTION:** Protection of Feeder (Radial & Ring Main) Using Over Current Relays, Protection of Transmission Line – Three Zone Protection Using Distance Relays.

**MODULE-5**

**NEUTRAL GROUNDING:** Advantages, Types of Neutral Grounding

**OVER VOLTAGE PROTECTION:** Causes of Over Voltages in Power Systems.-Phenomenon of Lightning, Protection against Lightning Over Voltages, Lightning Arresters –Rod Gap, Horn Gap, Valve Type and Zinc-Oxide Lighting Arresters.

| | |
|---|---|
| **Total hours:** | **48 hours** |

**Text Book(s):**

1. Power System Protection and Switchgear, Badri Ram, D.N Viswakarma, TMH Publications,2011.
2. Switchgear and Protection, Sunil S Rao, Khanna Publishers, 1992.

**Reference Book(s):**

1. Electrical Power Systems, C.L.Wadhwa, New Age international (P) Limited,Publishers, 2012.
2. Transmission network Protection, Y.G. Paithankar , Taylor and Francis,2009.
3. Power system protection and switch gear, Bhuvanesh Oza, TMH, 2010
4. Principles of power systems by V.K.Mehta,Rohith Mehta S.Chand(P), 4th Edition

**Term work:**

Field work to EHV Substation / Tutorials/ Quiz's

**Content beyond syllabus:**

1. Carrier current protection
2. Insulation Coordination, Basic Impulse Insulation Level

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Circuit Breakers | CO1 | https://www.electrical4u.com/electrical-circuit-breaker-operation-and-types-of-circuit-breaker/ |
| 2 | Protective relays | CO2 | https://circuitglobe.com/types-of-circuit-breaker.html |
| 3 | Electromagnetic Relays | CO3 | https://www.electrical4u.com/electromagnetic-relay-working-types-of-electromagnetic-relays/ |
| 4 | Generator protection | CO4 | https://circuitglobe.com/differential-protection-relay.html https://circuitglobe.com/impedance-type-distance-relay.html https://www.engineeringenotes.com/electrical-engineering/comparators/amplitude-comparators-and-its-types-devices-electrical-engineering/32806 |

| | | | | |
|---|---|---|---|---|
| | 5 | Neutral grounding | CO5 | https://circuitglobe.com/differential-protection-of-a-generator.html<br>https://circuitglobe.com/differential-protection-of-a-transformer.html<br>https://circuitglobe.com/feeder-protection.html#:~:text=Feeder%20Protection,the%20various%20type%20of%20fault. |

**Online Resources:**

1. http://175.101.102.82/moodle/course/view.php?id=691
2. https://subjects.ee.unsw.edu.au/elec9712/ELEC9712%20-%20Lec8%20-%20Circuit%20breakers%20Notes.pdf
3. https://b-ok.asia/book/5482781/8e4867
4. https://b-ok.asia/book/5482780/4ec690

**Web Resources:**

1. https://nptel.ac.in/courses/108/101/108101039/
2. https://www.youtube.com/watch?v=GSh0f94JwaA&t=54s
3. https://www.youtube.com/watch?v=dPInm2zoirA&t=40s
4. https://www.youtube.com/watch?v=OH7-NJRdDyA
5. https://www.youtube.com/watch?v=Kd_73FnTueI
6. https://www.youtube.com/watch?v=OElOqRSN0FE
7. https://www.youtube.com/watch?v=Y5dAaeLPzzk
8. https://www.youtube.com/watch?v=ODj4sWxKm9o

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2507 | ELECTRICAL MEASUREMENT & INSTRUMENTATION LAB | | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II-Semester | 0 | 0 | 2 | 30 | 1 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. Measurement of coefficient of coupling between two coupled coils.
2. Accurate determination of inductance and capacitance using D.C and A.C Bridges
3. Calibration of various electrical measuring instruments.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Accurately determine the values of inductance and capacitance using a a.c bridges |
| **CO 2** | Compute the coefficient of coupling between two coupled coils |
| **CO 3** | Calibrate various electrical measuring instruments |
| **CO 4** | Accurately determine the values of very low resistances |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 1 | 1 | 2 | 1 | | | | | 2 | 2 | | | | 1 |
| CO2 | 2 | 2 | 2 | 1 | | | | 1 | 2 | 2 | | | | 2 |
| CO3 | 2 | 2 | 1 | 1 | | | | 1 | 2 | 2 | | | | 1 |
| CO4 | 2 | 2 | 2 | 1 | 1 | | | 1 | 2 | 2 | | | | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### List of Experiments

TASK- 1 Calibration and Testing of Single phase energy meter

TASK- 2 Calibration of dynamometer wattmeter using phantom loading Test

TASK- 3 Calibration of dynamometer power factor meter

TASK- 4 Measurement of 3 -phase reactive power with single -phase wattmeter for balanced loading

TASK- 5 Measurement of parameters of a choke coil using 3-Voltmeter and 3-Ammeter methods

TASK- 6 Crompton D.C Potentiometer - Calibration of PMMC Ammeter and PMMC Voltmeter

TASK- 7 Kelvin's Double Bridge - Measurement of low resistance - Determination of Tolerance

TASK- 8 Capacitance Measurement using Schering Bridge

TASK- 9 Inductance Measurement using Anderson Bridge.

TASK- 10 LVDT and capacitance pickup - characteristics and calibration

**Additional Experiments:**

TASK- 11Measurement of 3-phase power by using Two Wattmeter method

TASK- 12 Resistance strain gauge- Strain measurement and calibration

| | |
|---|---|
| **Total hours:** | **36 hours** |

**Term work:**

Calibrate the Electrical & Electronics Instruments

**Content beyond syllabus:**

1. **Measurement of 3-phase power with single wattmeter and 2 No's CT**

**Online Resources:**

1.http://www.acadmix.com/eBooks_Download

**Web Resources:**

1. http://sreevahini.edu.in/pdf/electrical-measurements-lab.pdf
2. http://www.eee.griet.ac.in/wp-content/uploads/2014/12/EMI-Lab-Manual.pdf

| NARAYANA ENGINEERING COLLEGE: GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2508 | POWER SYSTEM LAB | | | | | | | R2021 |
| III-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II-Semester | 0 | 0 | 3 | 30 | 1.5 | 40 | 60 | 100 |

**Pre-requisite:** Must have the basic knowledge in Generation, Transmission & Distribution

**Course Objectives:**

1. To study the different methods of power system analysis.
2. To learn about the power system control.
3. To learn about the concepts of Power system stability.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Examine the power system analysis **(BL=4)** |
| **CO 2** | Identify characteristics of various Relays**(BL=3)** |
| **CO 3** | Understand various tests on Motors and Transformers **(BL=2)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 2 | 1 | 1 | | | | 2 | 2 | | 1 | 2 | 3 |
| CO2 | 2 | 2 | 1 | 1 | 1 | | | | 2 | 2 | | 1 | 2 | 3 |
| CO3 | 2 | 2 | 1 | 1 | 1 | | | | 2 | 2 | | 1 | 1 | 3 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**Task - 1 -** Determination of Sub transient Reactance of Salient Pole Synchronous Machine.

**Task -2 -** Determination of Sequence Impedances of Cylindrical Rotor Synchronous Machine.

**Task -3 -** LG -Fault Analysis.

**TASK -4 -** LLG -Fault Analysis.

**TASK -5 -** Equivalent Circuit of a Three Winding Transformer.

**TASK-6 -** Separation of No-Load Losses of Three-Phase Squirrel Cage Induction Motor.

**Task -7 -** LL -Fault Analysis.

**TASK -8 -** LLLG -Fault Analysis.

**TASK -9 -** Characteristics of IDMT Over Current Relay -Electromagnetic Type.

**TASK -10 -** Characteristics of Over Voltage Relay -Electromagnetic Type.

**TASK -11 -** Characteristics of Over Voltage Relay- Microprocessor Type.

**TASK -12 -** Characteristics of Percentage Biased Differential Relay-ElectromagneticType.

**Additional Experiments:**

**TASK -13 –** Performance of Digital Distance Relay.

**TASK -14 -** Characteristics of Percentage Biased Differential Relay- Static Type.

**Virtual Labs:**

1. http://www.ee.iitkgp.ac.in/faci_ps.php
2. https://vp-dei.vlabs.ac.in/Dreamweaver/list.html

**Self-Study:**

Contents to promote self-Learning:

| SNO | CO | Reference |
|---|---|---|
| 1 | **CO 1** | https://nptel.ac.in/courses/108/105/108105067/ |
| 2 | **CO 2** | https://nptel.ac.in/content/storage2/courses/108101039/download/Lecture-15.pdf |
| 3 | **CO 3** | https://nptel.ac.in/courses/108/105/108105017/ |

**Text Book(s):**

1. POWER SYSTEM ANALYSIS – by – HADI SAADAT - Tata McGraw-Hill Education, 01-Aug-2002.
2. Power System Protection and Switchgear, Badri Ram, D.N Viswakarma, TMH Publications, 2011.

**Reference Book(s):**

1. Power Systems Analysis, Grainger and Stevenson, Tata Mc Graw-hill, 2005.
2. Modern Power system Analysis 2nd edition, I.J.Nagrath&D.P.Kothari: Tata McGraw- Hill Publishing Company, 2003.
3. Kundur, P., "Power System Stability and Control", Mc. Graw Hill inc. 1994.
4. Jim Arlow, Ila Neustadt, "UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design", 2nd Edition, Pearson, (2005).

**Web Resources:**

1. http://www.academia.edu/Documents/in/Power-System-Analysis-by-Hadi-Saadat-Electrical-Engineering
2. https://nptel.ac.in/courses/108/101/108101040/
3. https://nptel.ac.in/courses/108/104/108104052/
4. https://nptel.ac.in/courses/108/105/108105067/
5. https://nptel.ac.in/courses/108/101/108101039/

## SEMESTER VII

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EN5001-5 | HS | Humanities and Social Science Elective | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| 21EE2014 | PC | Solid State Electric Drives | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2015 | PC | Power System Operation and Control | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | OE | Open Elective IV | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE40016-20 | PE | Professional elective IV | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE40021-25 | PE | Professional elective V | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21EE2509 | PC | Electronic systems design lab | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21EE2510 | PC | Power Systems Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 40 | 60 | 100 |
| 21CD6005 | SC | Career competency Development V | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21CC6501 | SC | Skill development Training | 0 | 0 | 2 | 2 | 1 | 40 | 60 | 100 |
| 21EE7502 | PR | Internship II/on job training/Com Ser Project | 0 | 0 | 0 | 0 | 1.5 | 00 | 100 | 100 |
| 21MC8002-13 | MC | Mandatory course IV | 2 | 0 | 0 | 2 | 0 | -- | -- | -- |
| | | Counseling/Mentori | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **19** | **0** | **12** | **31** | **23** | **400** | **700** | **1100** |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE2014 | SOLID STATE ELECTRICAL DRIVES | | | | | | R2021 |
| IV-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I-Semester | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand steady state operation and transient dynamics of a motor load system.
2. To study and analyze the operation of the converter fed dc drive, both qualitatively and quantitatively.
3. To study and analyze the operation of the chopper fed dc drive, both qualitatively and quantitatively.
4. To study and understand the operation and performance of AC Induction motor drives.
5. To study and understand the operation and performance of AC Synchronous motor drives.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Describe the basic requirements of motor selection for different load profiles. |
| **CO 2** | Analyze the operation of the converter fed dc drive |
| **CO 3** | Demonstrate the operation of the chopper fed dc drive |
| **CO 4** | Illustrate the operation and performance of AC Induction motor drives |
| **CO 5** | Analyze the induction motor drive using inverter |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**Electric Drive**

Classification of Electric Drives, Basic elements of Electric Drive, Introduction to Thyristor Controlled Drives, Single Phase Semi and Fully Controlled Converters Connected to D.C Separately Excited motor-Output Voltage and
Current Waveforms – Speed and Torque Expressions -problems.

**MODULE -2**

Three Phase Semi and Fully Controlled Converters Connected to D.C Separately Excited and D.C Series Motors – Continuous Current Operation – Output Voltage and Current Waveforms – Speed and Torque Expressions – Speed – Torque Characteristics- Problems. Introduction to Four Quadrant Operation – Motoring Operations, Electric Braking – Plugging, Dynamic and
Regenerative Braking Operations. Four Quadrant Operation of D.C Motors by Dual Converters

**MODULE-3**

**DC motor drives:**
Single Quadrant, Two Quadrant and Four Quadrant Chopper Fed DC Separately Excited and Series Excited Motors – Continuous Current Operation – Output Voltage and Current Wave Forms – Speed Torque Expressions – Speed Torque Characteristics.

**MODULE-4**

Induction Motor Stator Voltage Control and Characteristics. AC Voltage Controllers – Waveforms – Speed Torque Characteristics - Stator Frequency Control and Characteristics. Voltage Source and Current Source Inverter - PWM Control – Speed Torque Characteristics.

**MODULE-5**

**Induction motor drives:**
Static Rotor Resistance Control – Slip Power Recovery – V/f control of Induction Motor – Their Performance and Speed Torque Characteristics – Advantages- Applications – Problems.

**Synchronous motor drives:**
Separate Control & Self Control of Synchronous Motors – Operation of Self ControlledSynchronous Motors by VSI and CSI

| | |
|---|---|
| **Total hours:** | **48 hours** |

**Term work:**
Tutorials/Quizes

**Content beyond syllabus:**

1. Cycloconverter fed synchronous motor drives

**Self-Study:**

**Contents to promote self-Learning:**

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Thyristor Controlled Drives | CO1 | https://www.youtube.com/watch?v=-EC6q5_grM4 |
| 2 | Four Quadrant Operation | CO2 | https://www.youtube.com/watch?v=Tfrv9DJfVgs |
| 3 | Chopper Fed DC Motors | CO3 | https://www.youtube.com/watch?v=pdjVSWSQ83w |
| 4 | AC Voltage Controller fed AC drives | CO4 | https://www.youtube.com/watch?v=Pc7txXwvhBM |
| 5 | Slip Power Recovery scheme | CO5 | https://www.youtube.com/watch?v=9Z0Tn5iTYyE |

**Text Book(s):**

1. Power semiconductor controlled drives, G K Dubey, Prentice Hall, 1995.
2. Modern Power Electronics and AC Drives, B.K.Bose, PHI, 2002.

**Reference Book(s):**

1. Power Electronics, MD Singh and K B Khanchandani, Tata McGraw-Hill Publishing company, 2008.
2. Power Electronic Circuits, Devices and applications, M.H.Rashid, PHI, 2005.
3. Electric drives Concepts and Applications, Vedam Subramanyam, Tata McGraw Hill

**Online Resources:**

1. https://doku.pub/documents/electric-drives-by-gk-dubey-59qge6y3vm0n
2. https://nptel.ac.in/courses/108/104/108104140/

**Web Resources:**

1. https://www.youtube.com/watch?v=1AT1yuQ9awM&list=PLFW6lRTa1g83slfVY1p1xGqPGYUmXyahx
2. https://www.youtube.com/watch?v=WsDPqDqnpyw&list=PLuv3GM6-gsE3UGP1cSOl1KuEXscGFdKXB

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2015 | POWER SYSTEM OPERATION & CONTROL | | | | | | | R2021 |
| IV-B.Tech | Hours / Week | | | Total | Credit | Max Marks | | |
| | L | T | P | hrs | C | CIE | SEE | TOTAL |
| I-Semester | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the importance of optimal power flow and power system.
2. To Describe the hydrothermal scheduling, and its constraints.
3. To listen about single area and two area load frequency control , modeling of turbines
4. To understand the Deregulation, Restructuring models.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Enumerate the Heat rate curves, Economic operations of power systems |
| **CO 2** | Describe the Hydrothermal power stations Scheduling |
| **CO 3** | Discuss the single area load frequency control, modelling of turbines , speed governing systems. |
| **CO 4** | Illustrate two area load frequency control , tie line and economic dispatch control for load frequency control. |
| **CO 5** | Discuss the deregulation and conditions of deregulation in a power systems. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 1 | 2 | 2 | | 2 | | | | | | | | 3 | 2 |
| CO2 | 2 | 2 | 2 | | 2 | | | | | | | | 3 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO5 | 2 | 2 | 2 | | 2 | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**UNIT – ECONOMIC OPERATION OF THERMAL POWER STATION**

Over view of power system operation and Control, System Load variation, Formulation of Economic dispatch in Thermal Power station - Heat Rate Curve – Cost Curve –Incremental Fuel and Production Costs, Input-Output Characteristics , Constraints of power systems, Optimum Scheduling of Thermal power station.

**Optimum Generation Allocation:**

Optimum Generation Allocation with Line Losses Neglected. Loss Coefficients, General line loss formula, Optimum Generation Allocation with Line Losses.

**MODULE -2**

**UNIT–II-HYDROTHERMAL SCHEDULING and Governing**

Optimal scheduling of Hydrothermal system: Scheduling problems, Optimal Scheduling of Hydrothermal System,short term Hydro thermal Scheduling(4h)

**MODELLING OF TURBINE AND SPEED GOVERNING SYSTEM**

Modeling of Turbine: First Order Turbine Model, Approximate Linear models, Modeling of Governor,

Mathematical Modeling of Speed Governing System, Derivation of Small Signal Transfer Function – BlockDiagram (4h)

**MODULE-3**

**LOAD FREQUENCY SINGLE AREA CONTROL**

Necessity of Keeping Frequency Constant.–Definition of control Area, – Mathematical modeling of generator ,

loads, for LFC & corresponding block diagram representation, Block Diagram Representation of an Isolated PowerSystem – Steady State Analysis – Dynamic Response – Uncontrolled Case. (8h)

**MODULE-4**

**Load Frequency Control of 2-Area System: Load Frequency control of 2-Area system** and its Block diagram, Uncontrolled case and controlled case. Tie-Line Bias Control. Proportional Plus Integral Control of Single Area and Its Block Diagram Representation, Economic Dispatch Control.

**MODULE-5**

**Deregulation of Power system:**

Deregulation, Need and conditions for deregulation, Basics of public good economics, Components of Deregulation, Technical , economic & Regulatory issues involved in deregulation of power industry, Privatization, Competition in the electricity sector, conditions, barriers, benefits of Challenges, Reregulation.

**Total hours: 48 hours**

**Term work:**

Field work of power system operation & Deregulation in Thermal power plant

**Content beyond syllabus:**

1. **Knowledge of Voltage control in Power systems**

**Self-Study:**

**Contents to promote self-Learning:**

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Economic Operation of Thermal power station | CO1 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 2 | Hydro thermal scheduling | CO2 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 3 | Load frequency single area control | CO3 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 4 | Load frequency two area control | CO4 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 5 | Deregulation of Power system | CO5 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |

**Text Book(s):**

1. Power Generation Operaton and control - Wood and Wollenerg, wiley Publishers
2. Power systems operation and Control - Chakravarthi, Halder
3. D.P.Kothari and I.J.Nagrath, " Modern Power System Analysis" Tata Mc Graw Hill publishing company Ltd., 2003.

**Reference Book(s):**

1. S Sivanagaraju and G Sreenivasan, " Power System Operation and Control ", Pearson"MeriPustak-Machwan Communication & Research publishing Company Ltd,2004

2 Geoffrey Rothwell, Tomas Gomez (Eds), " Electricity Economics Regulation and Deregulation", IEEE Press Power Engineering series , John Wiley & Sons, 2003

3. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd, England, 2001
4. Mohammad Shahidehpour , Muwaffaq Alomoush, "Restructured Electric power Systems:Operation, Trading and Volatility", Marcel Dekker , Inc., 2001

**Online Resources:** http://175.101.102.82/moodle/course/view.php?id=610

1.http://www.acadmix.com/eBooks_Download

**Web Resources:** http://175.101.102.82/moodle/course/view.php?id=610

1.https://lecturenotes.in/notes/14667-note-for-power-system-operation-and-control-psoc-by-jntu-heroes?reading=true&continue=2

2.https://lecturenotes.in/notes/17488-note-for-power-system-operation-and-control-psoc-by-sucharita-das

3.http://www.crectirupati.com/sites/default/files/lecture_notes/PSOC%20-%20%20IV%20-%21EEE_0.pdf

4.http://www.tutorialspoint.com/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE2510 | POWER SYSTEM SIMULATION LAB | | | | | | | R2021 |
| IV-B.Tech | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I-Semester | 0 | 0 | 3 | 30 | 1.5 | 40 | 60 | 100 |

| **Pre-requisite: Nil** | |
|---|---|
| **Course Objectives:**<br>1. To study the different methods of power system analysis.<br>2. To learn about the power system control.<br>3. To learn about the concepts Power system stability. | |
| **Course Outcomes**: After successful completion of the course, the student will be able to: | |
| **CO 1** | Examine the power system analysis- (BL-4) |
| **CO 2** | Construct the controllers of a power system. (BL-3) |
| **CO 3** | Analyze the various power system stabilities- (BL-4) |

| **CO-PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO** | | | | | | | | | | | | **PSO** | |
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 2 | 2 | 2 | 1 | 2 | | | | 2 | 2 | | 1 | 2 | 3 |
| **CO2** | 2 | 2 | 1 | 1 | 2 | | | | 2 | 2 | | 1 | 2 | 3 |
| **CO3** | 2 | 2 | 1 | 1 | 2 | | | | 2 | 2 | | 1 | 1 | 3 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

| **Course content** |
|---|
| Task -1 Formation of bus admittance matrix (ybus). |
| Task -2 Power flow analysis using gauss seidal method. |
| Task -3 Power flow analysis using newton raphson method. |
| Task -4 Load flow analysis using fast decoupled method. |
| Task -5 Step response of two area system with and without. Integral control and estimation of frequency deviationusing simulink. |
| Task-6 Step response of two area system with integral Control and estimation of tie-line power deviation using Simulink. |
| Task -7Analysis of steady state stability of a single Machine connected to infinite bus using point by point method. |
| Task -8 Design of P-I-D controller. |
| Task -9 Design of fuzzy logic air conditioner. |
| Task -10 Load flow analysis using neural networks. |
| Task -11 Program for swing curve when the fault is cleared. |
| Task -12Swing curve for sustained fault and criticalclearing angle & time. |

| **Additional Experiments:** |
|---|
| Task -13 Design of kalman filter |
| Task - 14 Formation of bus impedance matrix($z_{bus}$) |
| Task - 15Matlab program to find optimum loading ofgenerators neglecting transmission losses |
| Task -16 Matlab program to find optimum loading of generators with penalty factors |

**Self-Study:**

Contents to promote self-Learning:

| SNO | CO | Reference |
|---|---|---|
| 1 | **CO 1** | https://nptel.ac.in/courses/108/105/108105067/ |
| 2 | **CO 2** | 1. https://nptel.ac.in/courses/108/101/108101040/<br>2. https://nptel.ac.in/courses/108/104/108104052/ |
| 3 | **CO 3** | 1. https://nptel.ac.in/courses/108/101/108101040/<br>2. https://nptel.ac.in/courses/108/104/108104052/ |

**Text Book(s):**

1. POWER SYSTEM ANALYSIS – by – HADI SAADAT - Tata McGraw-Hill Education, 01-Aug-2002.
2. MATLAB for Electrical Engineers and Technologists: MATLAB Tutorial with Practical Electrical Examples- Stephen P. Tubbs, 2010

**Reference Book(s):**

1. Power Systems Analysis, Grainger and Stevenson, Tata Mc Graw-hill, 2005.
2. Modern Power system Analysis 2nd edition, I.J.Nagrath & D.P.Kothari: Tata McGraw- Hill Publishing Company, 2003.
3. Kundur, P., “Power System Stability and Control”, Mc. Graw Hill inc. 1994.
2. Jim Arlow, Ila Neustadt, “UML 2 and the Unified Process: Practical Object-Oriented
3. Analysis and Design”, 2nd Edition, Pearson, (2005).

**Web Resources:**

1. http://www.academia.edu/Documents/in/Power-System-Analysis-by-Hadi-Saadat-Electrical-Engineering
2. https://nptel.ac.in/courses/108/101/108101040/
3. https://nptel.ac.in/courses/108/104/108104052/
4. https://nptel.ac.in/courses/108/105/108105067/

SEMESTER VIII

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 21EE7503 | **PR** | Project work, seminar and internship | 0 | 0 | 0 | 0 | 12 | 60 | 140 | 200 |
| | | | **0** | **0** | **0** | **0** | **12** | **60** | **140** | **200** |

PROFESSIONAL ELECTIVES (PE)

| Elective Track/Group | Professional Elective-1 | Professional Elective-2 | Professional Elective-3 | Professional Elective-4 | Professional Elective-5 |
|---|---|---|---|---|---|
| Advanced Power systems | Industrial Electrical Systems (21EE4001) | Power System Planning (21EE4006) | Reactive Power Compensation and Management (21EE4011) | Power Quality (21EE4016) | Smart Grid Technologies (21EE4021) |
| Control Systems | System Modeling and Identification (21EE4002) | Advanced Control systems (21EE4007) | Digital Signal Processing (21EE4012) | Multivariable Control System (21EE4017) | Real Time Control System (21EE4022) |
| Electromechanical Systems | Machine Modeling and Analysis (21EE4003) | Electrical Machine Design (21EE4008) | Programmable Control Devices and Applications (21EE4013) | Hybrid Electrical Vehicles (21EE4018) | Automotive Electrical Engineering (21EE4023) |
| Energy Systems | Renewable Energy Conversion Systems (21EE4004) | Solar and Fuel Cell Energy Systems (21EE4009) | Wind and Biomass Energy Systems (21EE4014) | Utilization of Electrical Energy (21EE4019) | Energy Audit and Demand side Management (21EE4024) |
| Power Electronics | Advanced Power Electronics (21EE4005) | Advanced Electrical Drives (21EE4010) | HVDC and FACTS (21EE4015) | Advanced Power Converters (21EE4020) | Advanced Power Semiconductor Devices and Protection (21EE4025) |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4001 | INDUSTRIAL ELECTRICAL SYSTEMS | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To make students understand the fundamental theory governing the photovoltaic devise and make them carry out preliminary system design.
2. To learn the fundamental knowledge about various fuel cell technologies.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the electrical wiring systems for residential, commercial and industrial consumers through symbols, drawings and SLD (BL-2) |
| **CO 2** | Justify the need of industrial electrical system components and industrial automation (BL-3) |
| **CO 3** | Analyze the size, rating and cost of electrical installations for residential and commercial applications (BL-4) |
| **CO 4** | Analyze the appropriate electrical system with protective equipments for industrial applications (BL-4) |
| **CO 5** | Understand the role of industrial automation (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 2 | | | | | | | | | | 2 | 1 |
| CO2 | 3 | 2 | | | | | | | | | | | 3 | 2 |
| CO3 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | | | | | | | | | 3 | 3 |
| CO5 | 2 | 2 | | | 2 | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Electrical System Components | 10 Hours |
|---|---|---|

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, Protection components- Fuse, MCB, MCCB, ELCB, Symbols for wiring components, Single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

At the end of the Module 1, students will be able to:

1. Understand the different types protecting devices (BL-2)
2. Discuss the various performance characteristics of protecting devices.(BL-2)

| MODULE -2 | Residential and Commercial Electrical Systems | 10 Hours |
|---|---|---|

Types of residential and commercial wiring systems, General rules and guidelines for installation, Load calculation and sizing of wire, Rating of main switch, distribution board and protection devices, Earthing system calculations, Requirements of commercial installation, Deciding lighting scheme and number of lamps, Earthing of commercial installation, Selection and sizing of components

At the end of the Module 2, students will be able to:

1. Discuss the different types of wiring systems (BL-3)
2. Discuss the concepts of Earthing system and its calculation (BL-3)

| MODULE-3 | Illumination Systems | 09 Hours |
|---|---|---|
| Understanding various terms regarding light- lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, Various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, Energy saving in illumination systems, Design of a lighting scheme for a residential and commercial premises, Flood lighting | | |
| At the end of the Module 3, students will be able to:<br>1. Predict the performance of various lighting systems in industry. (BL-4) | | |
| **MODULE-4** | **Industrial Electrical Systems** | **10 Hours** |
| HT connection, Industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components<br>DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks | | |
| At the end of the Module 4, students will be able to:<br>1. Analyze the application of various equipments in industrial electrical system. (BL-4) | | |
| **MODULE-5** | **Industrial Electrical System Automation** | **09 Hours** |
| Study of basic PLC, Role of automation, Advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation | | |
| At the end of the Module 5, students will be able to:<br>1. Understand the performance of industrial automation for better operation of industry. (BL-2) | | |
| | **Total hours:** | **48 hours** |

**Term work:**

1. Field trip

**Content beyond syllabus:**

1. Introduction of hydrogen energy systems
2. Hydrogen production processes
3. Hydrogen storage and safety

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | Electric shock and Electrical safety practices | https://electrical-engineering-portal.com/21-safety-rules-for-working-with-electrical-equipment |
| 2 | General rules and guidelines for installation | https://www.tutorhelpdesk.com/homeworkhelp/Engineering-/General-Rules-For-Wiring-Assignment-Help.html |
| 3 | Flood lighting | https://www.tutorialspoint.com/what-is-flood-lighting-definition-purpose-calculation-and-applications |
| 4 | Selection of UPS and Battery Banks | https://myelectrical.com/notes/entryid/164/ups-battery-sizing#:~:text=Example%20of%20UPS%20battery%20sizing,cells%20of%202%20V%20each). |
| 5 | Introduction to SCADA system for distribution automation | https://www.scadalink.com/support/knowledge-base/an-introduction-to-scada/#:~:text=The%20term%20SCADA%20stands%20for,for%20control%20or%20monitoring%20purposes. |

**Text Book(s):**

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
3. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.

**Reference Book(s):**

1. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008
2. 5. IS Standards : https://bis.gov.in

**Online Resources:**

1. https://electrical-engineering-portal.com/21-safety-rules-for-working-with-electrical-equipment
2. https://www.tutorhelpdesk.com/homeworkhelp/Engineering-/General-Rules-For-Wiring-Assignment-Help.html
3. https://www.tutorialspoint.com/what-is-flood-lighting-definition-purpose-calculation-and-applications
4. https://myelectrical.com/notes/entryid/164/ups-battery-sizing#:~:text=Example%20of%20UPS%20battery%20sizing,cells%20of%202%20V%20each).
5. https://www.scadalink.com/support/knowledge-base/an-introduction-to-scada/#:~:text=The%20term%20SCADA%20stands%20for,for%20control%20or%20monitoring%20purposes.

**Web References:**

1. https://nptel.ac.in/courses/108107112

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4006 | POWER SYSTEM PLANNING | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To make students understand the fundamental theory governing the power system planning and forecasting.
2. To make the students to understand the economics related to expansion of power system.
3. To learn the fundamental knowledge about transmission and distribution planning for future expansion.
4. To make the students to understand the reliability concept in power system to better operation of power system.
5. To make the students to make the planning with respect to electricity market based demand.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Discuss primary components of power system planning, planning methodology for optimum power system expansion and show knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools. (BL-2) |
| **CO 2** | Discuss methods to mobilize resources to meet the investment requirement for the power sector and understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions to power generation and planning for system energy in the country (BL-2) |
| **CO 3** | Analyze the operating states of transmission system, their associated contingencies and the stability of the system and discuss principles of distribution planning, supply rules, network development and the system studies. (BL-4) |
| **CO 4** | Discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis, grid reliability, voltage disturbances and their remedies (BL-2) |
| **CO 5** | Discuss planning and implementation of electric –utility activities, market principles and the norms framed by CERC for online trading and exchange in the interstate power market. (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 2 | 2 | 1 | 2 | | 2 | 2 | 2 | | 2 | 2 | 1 |
| CO2 | 2 | 3 | 2 | 1 | 2 | 2 | | 2 | | | | 2 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 2 | | 1 | 2 | 2 | | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 1 | 2 | | 2 | | | | 2 | 3 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | | 2 | 2 | 1 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

| COURSE CONTENT | | |
|---|---|---|
| **MODULE – 1** | Power System | **10 Hours** |

**Power System:**

Power Systems, Planning Principles, Planning Process, Project Planning, Power Development, Power Growth, National and Regional Planning, Enterprise Resources Planning, Structure of a Power System, Power Resources, Planning Tools, Power Planning Organisation, Regulation, Scenario Planning.

**Electricity Forecasting:**

Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.

At the end of the Module 1, students will be able to:

1. Discuss primary components of power system planning, planning methodology for optimum power system expansion, various types of generation, transmission and distribution.
2. Show knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.

| **MODULE -2** | Power-System Economics | **10 Hours** |
|---|---|---|

**Power-System Economics:**

Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation Units, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment, Optimum Investment, Tariffs.

**Generation Expansion:**

Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies, Distributed Power Generation, Renovation and Modernization of Power Plants.

At the end of the Module 2, students will be able to:

- Discuss methods to mobilize resources to meet the investment requirement for the power sector
- Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions
- Discuss expansion of power generation and planning for system energy in the country

| **MODULE-3** | **Transmission & Distribution Planning:** | **08 Hours** |
|---|---|---|

**Transmission:**

Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage.

**Distribution:**

Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity, Distribution(continued): Upgradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification, Villages Self – Sufficiency in Energy,

| | | |
|---|---|---|
| Community Power, Self – Generation. | | |
| At the end of the Module 3, students will be able to:<br>• Evaluation of operating states of transmission system, their associated contingencies and the stability of the system.<br>• Discuss principles of distribution planning, supply rules, network development and the system studies | | |
| **MODULE-4** | **Reliability and Quality** | **10 Hours** |
| Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Reliability Target, Security Requirement, Disaster Management, Quality of Supply, Reliability and Quality Roadmap. | | |
| At the end of the Module 4, students will be able to:<br>• Discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis, grid reliability, voltage disturbances and their remedies | | |
| **MODULE-5** | Demand-Side Planning | **10 Hours** |
| **Demand-Side Planning:**<br>Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit.<br>**Electricity Market:**<br>Market Principles, Power Pool, Independent System Operator, Distribution System Operator, Power Balancing, Market Participants, Power Markets, Market Rules, Bidding, Trading, Settlement System, Locational Marginal Pricing, Transmission Charges, Merchant Power, Differential Electricity, Congestion Management, Ancillary Services, Hedging, Smart Power Market. | | |
| At the end of the Module 5, students will be able to:<br>• Discuss planning and implementation of electric –utility activities, market principles and the norms framed by CERC for online trading and exchange in the interstate power market. | | |
| | **Total hours:** | **48 hours** |

| |
|---|
| **Term work:**<br>1. Open book based exam |
| **Content beyond syllabus:**<br>1. |

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | Power System Regulation, Scenario Planning | https://www.nrel.gov/docs/fy08osti/42297.pdf |
| 2 | Modernization of Power Plants | https://www.powermag.com/history-of-power-plant-renovation-and-modernization-in-india/#:~:text=The%20GoI%20initiated%20a%20new,the%20existing%20thermal%20power%20plants. |
| 3 | Reactive Power Planning | https://www.igi-global.com/dictionary/reactive-power-planning/63461 |
| 4 | Reliability and Quality Roadmap | https://www.slideshare.net/ASQwebinars/reliability-roadmap-using-quality-function-deployment |
| 5 | Smart Power Market | https://www.alliedmarketresearch.com/smart-energy-market-A09434 |

**Text Book(s):**

1. Electric Power Planning A. S. Pabla McGraw Hill, 2nd Edition, 2016

**Online Resources:**

1. https://www.nrel.gov/docs/fy08osti/42297.pdf
2. https://www.powermag.com/history-of-power-plant-renovation-and-modernization-in-india/#:~:text=The%20GoI%20initiated%20a%20new,the%20existing%20thermal%20power%20plants.
3. https://www.igi-global.com/dictionary/reactive-power-planning/63461
4. https://www.slideshare.net/ASQwebinars/reliability-roadmap-using-quality-function-deployment
5. https://www.alliedmarketresearch.com/smart-energy-market-A09434

**Web References:**

1. https://nptel.ac.in/courses/108101040

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4011 | **Reactive Power Compensation and Management** | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

- To identify the necessity of reactive power compensation
- To describe load compensation
- To select various types of reactive power compensation in transmission systems
- To contrast reactive power coordination system
- To characterize distribution side and utility side reactive power management.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads (BL-3) |
| **CO 2** | Observe various compensation methods in transmission lines (BL-2) |
| **CO 3** | Construct model for reactive power coordination (BL-3) |
| **CO 4** | Understand the demand side reactive power management (BL-2) |
| **CO 5** | Understand the user side reactive power management (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 3 | 2 | 2 | | 2 | | | | | 2 | | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | | 2 | | | | | 2 | | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | | 2 | | | | | 2 | | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | | 2 | | | | | 2 | | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | | 2 | | | | | 2 | | 2 | 1 |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | | |
|---|---|---|
| **MODULE – 1** | **Load Compensation** | **10 Hours** |
| Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples. | | |
| At the end of the Module 1, students will be able to:<br>1. Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads (BL-3) | | |
| **MODULE -2** | **Steady – State Reactive Power Compensation in Transmission System** | **10 Hours** |
| Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation –examples Transient state reactive power compensation in transmission systems: Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples | | |
| At the end of the Module 2, students will be able to:<br>1. Observe various compensation methods in transmission lines (BL-2) | | |
| **MODULE-3** | **Reactive Power Coordination** | **09 Hours** |

| | | |
|---|---|---|
| Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences | | |
| At the end of the Module 3, students will be able to:<br>1. Construct model for reactive power coordination (BL-3) | | |
| **MODULE-4** | **Demand Side Management** | **10 Hours** |
| Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels Distribution side Reactive power Management:: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks | | |
| At the end of the Module 4, students will be able to:<br>1. Understand the demand side reactive power management (BL-2) | | |
| **MODULE-5** | **User Side Reactive Power Management** | **09 Hours** |
| KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace | | |
| At the end of the Module 5, students will be able to:<br>1. Understand the user side reactive power management (BL-2) | | |
| **Total hours:** | | **48 hours** |

**Term work:**

1.

**Content beyond syllabus:**

1. Modern tool usage to analyze the reactive power in power system

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | power factor correction of unsymmetrical loads | http://ethesis.nitrkl.ac.in/6395/1/E-8.pdf |
| 2 | series capacitor compensation | https://circuitglobe.com/series-compensation.html |
| 3 | radio frequency and electromagnetic interferences | https://en.wikipedia.org/wiki/Electromagnetic_interference |
| 4 | retrofitting of capacitor banks | https://www.theelectricalguy.in/tutorials/5-types-of-power-factor-correction-capacitor-bank-locations/ |
| 5 | power factor of an arc furnace | https://www.ijert.org/research/power-quality-improvement-in-electric-arc-furnace-IJERTV4IS040198.pdf |

**Text Book(s):**

- Reactive power control in Electric power systems by T.J.E. Miller, John Wiley and sons, 1982.
- Reactive power Management by D. M. Tagare, Tata McGraw Hill, 2004.

**Reference Book(s):**

- Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just "Reactive Power Compensation: A Practical Guide, April, 2012, Wiely publication.

**Online Resources:**

1. http://ethesis.nitrkl.ac.in/6395/1/E-8.pdf
2. https://circuitglobe.com/series-compensation.html
3. https://en.wikipedia.org/wiki/Electromagnetic_interference
4. https://www.theelectricalguy.in/tutorials/5-types-of-power-factor-correction-capacitor-bank-locations/
5. https://www.ijert.org/research/power-quality-improvement-in-electric-arc-furnace-IJERTV4IS040198.pdf

**Web References:**

1. https://www.youtube.com/watch?v=OR5Fdfh9Hbw

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4016 | POWER QUALITY | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. Power quality issues and standards.
2. The sources of power quality disturbances and power transients that occur in power systems.
3. The sources of harmonics, harmonic indices, Devices for controlling harmonic distortion.
4. The principle of operation of DVR and UPQC.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Address power quality issues to ensure meeting of standards (BL-2) |
| **CO 2** | Apply the concepts of compensation for sags and swells using voltage regulating devices (BL-3) |
| **CO 3** | Assess harmonic distortion and its mitigation. (BL-4) |
| **CO 4** | Understand the power measurement data according to standards (BL-2) |
| **CO 5** | Analyze the power quality improvement with custom power devices (BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | | | | | | | | | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | | | | | | | | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | | | | | | | | 3 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 2 | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | INTRODUCTION | 10 Hours |
|---|---|---|

Definition of Power Quality- Power Quality Terminology – Classification of Power Quality Issues- Magnitude Versus Duration Plot - Power Quality Standards - Responsibilities of Suppliers and Users of Electric Power-CBEMA and ITI Curves.

At the end of the Module 1, students will be able to:

1. Address power quality issues to ensure meeting of standards (BL-2)

| MODULE -2 | TRANSIENTS, SHORT DURATION AND LONG DURATION VARIATIONS | 10 Hours |
|---|---|---|

Categories and Characteristics of Electromagnetic Phenomena in Power Systems- Impulsive and Oscillatory Transients-Interruption - Sag-Swell-Sustained Interruption - Under Voltage – Over Voltage–Outage. Sources of Different Power Quality Disturbances- Principles of Regulating the Voltage- Conventional Devices for Voltage Regulation.

At the end of the Module 2, students will be able to:

1. Apply the concepts of compensation for sags and swells using voltage regulating devices (BL-3)

| MODULE-3 | FUNDAMENTALS OF HARMONICS & APPLIED HARMONICS | 09 Hours |
|---|---|---|
| Harmonic Distortion, Voltage Versus Current Distortion, Harmonics Versus Transients, Power System Quality Under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads. Applied Harmonics**:** Effects Of Harmonics, Harmonic Distortion Evaluations, Principles of Controlling Harmonics, Devices for Controlling Harmonic Distortion. | | |
| At the end of the Module 3, students will be able to:<br>1. Assess harmonic distortion and its mitigation. (BL-4) | | |
| **MODULE-4** | **POWER QUALITY MONITORING** | **10 Hours** |
| Power Quality Benchmarking-Monitoring Considerations- Choosing Monitoring Locations-Permanent Power Quality Monitoring Equipment-Historical Perspective of Power Quality Measuring Instruments- Power Quality Measurement Equipment-Types of Instruments- Assessment of Power Quality Measurement Data- Power Quality Monitoring Standards. | | |
| At the end of the Module 4, students will be able to:<br>1. Understand the power measurement data according to standards (BL-2) | | |
| **MODULE-5** | **POWER QUALITY ENHANCEMENT USING CUSTOM POWER DEVICES** | **09 Hours** |
| Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL)-Solid State Breaker (SSB) -Solid State Transfer Switch (SSTS) - Compensating Type: Dynamic Voltage Restorer (DVR)-Unified Power Quality Conditioner(UPQC)-Principle of Operation Only. | | |
| At the end of the Module 5, students will be able to:<br>1. Analyze the power quality improvement with custom power devices (BL-4) | | |
| **Total hours:** | | **48 hours** |

**Term work:**

1.

**Content beyond syllabus:**

1. AI based power quality improvement methods.

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | Responsibilities of Suppliers and Users of Electric Power | https://pure.tue.nl/ws/files/2804575/712690.pdf |
| 2 | Conventional Devices for Voltage Regulation | https://www.electrical4u.com/voltage-regulator/ |
| 3 | Devices for Controlling Harmonic Distortion | https://www.brainkart.com/article/Devices-for-Controlling-Harmonic-Distortion_11725/ |
| 4 | Power Quality Monitoring Standards | https://www.engineeringenotes.com/electrical-engineering/power-quality/standards-for-monitoring-power-quality-electricity/32560 |
| 5 | Custom Power Devices | https://www.ripublication.com/irph/ijeee_spl/ijeeev7n7_11.pdf |

**Text Book(s):**

1. Electrical Power Systems Quality, Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H.Wayne Beaty, Mc Graw Hill Education (India) Pvt. Ltd., 3rd Edition, 2012.
2. Power quality, C. Sankaran, CRC Press, 2001.

**Reference Book(s):**

1. Understanding Power quality problems – Voltage Sags and Interruptions, Math H. J. Bollen IEEE Press Series on Power Engineering, WILEY, 2007.
2. Power quality – VAR Compensation in Power Systems, R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2009, First Indian Reprint 2013.
3. Fundamentals of Electric Power Quality, Surya Santoso, Create Space, 2012.

**Online Resources:**

1. https://pure.tue.nl/ws/files/2804575/712690.pdf
2. https://www.electrical4u.com/voltage-regulator/
3. https://www.brainkart.com/article/Devices-for-Controlling-Harmonic-Distortion_11725/
4. https://www.engineeringenotes.com/electrical-engineering/power-quality/standards-for-monitoring-power-quality-electricity/32560
5. https://www.ripublication.com/irph/ijeee_spl/ijeeev7n7_11.pdf

**Web References:**

1. https://onlinecourses.nptel.ac.in/noc21_ee103/preview

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4021 | SMART GRID TECHNOLOGIES | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

- To understand various aspects of smart grid
- To study various smart transmission and distribution technologies
- To appreciate distribution generation and smart consumption
- To know the regulations and market models for smart grid

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand technologies for smart grid (BL-2) |
| **CO 2** | Understand the smart transmission system and its technologies (BL-2) |
| **CO 3** | Understand the smart distribution system and its technologies (BL-2) |
| **CO 4** | Realize the distribution generation and smart consumption (BL-3) |
| **CO 5** | Know the regulations and market models for smart grid (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 3 | 2 | | 2 | 2 | | | | | | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | | 2 | 2 | | | | | | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | | 2 | 2 | | | | | | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | | 2 | 2 | 2 | | | | | 3 | 3 |
| CO5 | 3 | 3 | 3 | 2 | | 2 | 2 | 2 | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Introduction to Smart Grids | 10 Hours |
|---|---|---|

Definition, justification for smart grids, smart grid conceptual model, smart grid architectures, Interoperability, communication technologies, role of smart grids standards, intelligrid initiative, national smart grid mission (NSGM) by Govt. of India

At the end of the Module 1, students will be able to:

1. Understand technologies for smart grid (BL-2)

| MODULE -2 | Smart Transmission Technologies | 10 Hours |
|---|---|---|

Substation automation, Supervisory control and data acquisition (SCADA), energy management system (EMS), phasor measurement units (PMU), Wide area measurement systems (WAMS)

At the end of the Module 2, students will be able to:

1. Understand the smart transmission system and its technologies (BL-2)

| MODULE-3 | Smart Distribution Technologies | 09 Hours |
|---|---|---|
| Distribution automation, outage management systems, automated meter reading (AMR), automated metering infrastructure (AMI), fault location isolation and service restoration (FLISR), Outage Management Systems (OMS), Energy Storage, Renewable Integration | | |
| At the end of the Module 3, students will be able to:<br>1. Understand the smart distribution system and its technologies (BL-2) | | |
| **MODULE-4** | Distributed Generation and Smart Consumption | **10 Hours** |
| Distributed energy resources (DERs), smart appliances, low voltage DC (LVDC) distribution in homes / buildings, home energy management system (HEMS), Net Metering, Building to Grid B2G, Vehicle to Grid V2G, Solar to Grid, Microgrid | | |
| At the end of the Module 4, students will be able to:<br>1. Realize the distribution generation and smart consumption (BL-3) | | |
| **MODULE-5** | Regulations and Market Models for Smart Grid | **09 Hours** |
| Demand Response, Tariff Design, Time of the day pricing (TOD), Time of use pricing (TOU), Consumer privacy and data protection, consumer engagement etc. Cost benefit analysis of smart grid projects. | | |
| At the end of the Module 5, students will be able to:<br>1. Know the regulations and market models for smart grid (BL-2) | | |
| **Total hours:** | | **48 hours** |

**Content beyond syllabus:**

1. Cost Estimation of Smart Gird in India

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | National smart grid mission (NSGM) by Govt. of India | https://www.nsgm.gov.in/#:~:text=NSGM%20Establishment,January%202016%20with%20dedicated%20team. |
| 2 | Wide area measurement systems (WAMS) | https://www.energy.gov/sites/default/files/oeprod/DocumentsandMedia/8-Securing_WAMS.pdf |
| 3 | Renewable Integration | https://www.energy.gov/oe/services/technology-development/renewable-energy-integration |
| 4 | Home energy management system (HEMS) | https://www.osti.gov/servlets/purl/1423114 |
| 5 | Cost benefit analysis of smart grid projects | https://www.slideshare.net/sustenergy/multicriteria-and-cost-benefit-analysis-for-smart-grid-projects |

**Text Book(s):**

1. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response"- CRC Press, 2009.
2. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley-ISTE, IEEE Press, May 2012

**Reference Book(s):**

- Janaka Ekanayake, Kithsiri Liyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
- James Momoh, "Smart Grid: Fundamentals of Design and Analysis" – Wiley, IEEE Press, 2012.

**Online Resources:**

1. https://www.nsgm.gov.in/#:~:text=NSGM%20Establishment,January%202016%20with%20dedicated%20team.
2. https://www.energy.gov/sites/default/files/oeprod/DocumentsandMedia/8-Securing_WAMS.pdf
3. https://www.energy.gov/oe/services/technology-development/renewable-energy-integration
4. https://www.osti.gov/servlets/purl/1423114
5. https://www.slideshare.net/sustenergy/multicriteria-and-cost-benefit-analysis-for-smart-grid-projects

**Web References:**

1. India Smart Grid Knowledge Portal

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4002 | System Modelling and Identification | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | ACS | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1.To Understand the Modelling of Dynamic Systems
2 To Understand the Stability margins, correlation of frequency domain and time domain
3. To Understand the Concepts of linear sampled data systems
4. To Understand the computation Z-transform
5. To Understand the compensation in Z domain and W plane

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Learn the design of Modelling of Dynamic Systems |
| **CO 2** | Analyze the Stability margins, correlation of frequency domain and time domain |
| **CO 3** | Analyse linear sampled data systems |
| **CO 4** | Learn the computation Z-transform |
| **CO 5** | Understand the compensation in Z domain and W plane |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 2 | 1 | 1 | | | | | | | | | | 1 | 1 |
| **CO2** | 3 | | 1 | | | | | | | | | | 1 | 1 |
| **CO3** | 1 | 2 | | | | | | | | | | | | 1 |
| **CO4** | 1 | 2 | 1 | | | | | | | | | | 1 | 1 |
| **CO5** | 1 | | 2 | | | | | | | | | | | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**Modelling of Dynamic Systems**

State variable Modelling of Continuous Dynamic Systems.
Solution methods for Nonlinear Differential equations. Bond Graph Techniques.

At the end of the Module 1, students will be able to:

1. Understand the importance of State variable approach
2. Analyze Nonlinear Differential equations

**MODULE -2**

**Classical control theory:**

Review of classical control theory: Stability margins, correlation of frequency domain and time domain parameters, design specifications, compensation of continuous systems, actuator selection and design.
State variable modelling of linear continuous systems, controllability and observability

At the end of the Module 2, students will be able to:

1. Understand the Stability margins
2. Analyze correlation of frequency domain and time domain parameters, design
3. Understand the concepts of controllability and observability

**MODULE-3**

| |
|---|
| **Concepts of linear sampled data systems:** Discrete equivalents of continuous data systems, reconstruction of sampled signals, sample and 0 order holds, stability of linear sampled data systems.<br>State variable modelling of linear discrete data systems, controllability and observability. |
| At the end of the Module 3, students will be able to:<br>1. Analyze stability of linear sampled signals.<br>2. Understand the State variable modelling of linear discrete data systems |
| **MODULE-4** |
| **Digital Control Theory**: **I**<br>Review of Z-transform. Computation of time response of Discrete Data system. Bilinear Transformation. W-plane, prewarping, inverse transformation. Design of discrete controllers. |
| At the end of the Module 4, students will be able to:<br>1. Understand the Z-transform & Bilinear Transformation<br>2. Analyze the design of discrete controllers |
| **MODULE-5** |
| **Digital Control Theory**: **II**<br>Z-domain compensation, w-plane compensation, state variable feedback, deadbeat controller sampled data version of PID controllers. Effect of Data Digitization. Effect of finite word size, limit cycle Determination. |
| At the end of the Module 5, students will be able to:<br>1. Analyze compensations in Z domains, W domains<br>2. Understand the concepts of controllers |
| **Total hours: 50 hours** |

**Term work:**
Assignments followed by quizzes

**Content beyond syllabus:**
Simulation Software. Skeletal Structure of Simulation software

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Bond Graph Techniques | CO1 | https://researchonline.gcu.ac.uk/ws/portalfiles/portal/3218404/bond_graph_modeling_postprint.pdf |
| 2 | State variable modelling of linear continuous systems | CO2 | https://www.ijert.org/state-variable-analysis-of-continuous-time-systems |
| 3 | controllability and observability | CO3 | https://www.ece.rutgers.edu/~gajic/psfiles/chap5traCO.pdf |
| 4 | W-plane, prewarping | CO4 | https://en.wikibooks.org/wiki/Digital_Signal_Processing/Bilinear_Transform |
| 5 | Effect of finite word size | CO5 | http://www.dsp-book.narod.ru/DSPMW/03.PDF |

**Text Book(s):**
1. G.P. Rao, "Identification of continuous-time systems" suggested by Kranthi Deveerasetty (Entry level)

2. Modeling & Identification of Dynamic Systems Hardcover – Import, 23 August 2016
by Lennart Ljung (Author), Torkel Glad (Author)

3. K. P. Mohandas, “Modern Control Engineering”, Sanguine Technical Publishers, 2006.

**Reference Book(s):**

1. Highlights of system identification provided by Manuel De la Sen.
. Heij, A.C.M. Ran, F. van Schagen, "Introduction to Mathematical Systems Theory: Linear Systems, Identification and Control" suggested by Mahmood Dadkhah
2.System Identification: An Introduction Book by Karel J. Keesman

**Online Resources:**

1. https://ptolemy.berkeley.edu/books/Systems/PtolemyII_DigitalV1_02.pdf

**Web Resources:**

1. https://hal.archives-ouvertes.fr/hal-00718864/document
2. https://www.mathworks.com/help/ident/gs/about-system-identification.html

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4007 | ADVANCED CONTROL SYSTEMS | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | ACS | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To Understand state feedback control and state observer
2. To Understand the phase plane analysis
3. To Understand the Analysis of describing functions with non-linearities
4. To Understand the design of optimal controller
5. To Understand the design of optimal estimator including Kalman Filter, Lyapunov's Stability

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Learn the design of state feedback controller and state observer |
| **CO 2** | Analyze the linear and nonlinear systems using phase plane method. |
| **CO 3** | Analyse nonlinear systems using describing function method.. |
| **CO 4** | Learn the optimal control problem |
| **CO 5** | Understand the Solution of Kalman Filter by duality principle, Direct method of Lypanov for Linear and Nonlinear continuous time autonomous systems. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 1 | 1 | | | | | | | | | | 1 | 2 |
| CO2 | 3 | | 1 | | | | | | | | | | 1 | 1 |
| CO3 | 1 | 2 | | | | | | | | | | | | 1 |
| CO4 | 2 | 2 | 3 | | | | | | | | | | 1 | 2 |
| CO5 | 2 | | 1 | | | | | | | | | | | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**STATE VARIABLE DESIGN**:

Introduction to state model: Effect of state feedback - Pole placement design: Necessary and sufficient condition for arbitrary pole placement, State regulator design - Design of state observers- Separation principle- Design of servo systems: State feedback with integral control

At the end of the Module 1, students will be able to:

1. Understand the importance of State variable approach
2. Analyze the state observers and pole placement
3. Develop the State feedback with integral control

**MODULE -2**

**PHASE PLANE ANALYSIS:**

Features of linear and non-linear systems - Common physical non-linearities – Phase plane method: Basic concept, Singular points, Limit cycles, Phase trajectories - Construction of phase trajectories of linear and non-linear systems: Analytical method, Isocline method.

At the end of the Module 2, students will be able to:

1. Understand the Features of linear and non-linear systems
2. Implement the Phase plane method
3. Understand the Construction of phase trajectories of linear and non-linear systems

**MODULE-3**

**DESCRIBING FUNCTION ANALYSIS:**
Basic concepts, Derivation of describing functions for common non-linearities: Dead zone, Saturation, Relay, Hysteresis, Backlash – Describing function analysis of non-linear systems, Limit cycles, Stability of oscillations.

At the end of the Module 3, students will be able to:

1. Derive the describing functions for common non-linearities.
2. Understand the concept of Stability of oscillations

**MODULE-4**

**OPTIMAL CONTROL:**
Introduction: Classical control and optimization, formulation of optimal control problem, Typical optimal control performance measures - Optimal state regulator design: Lyapunov equation, Matrix Riccati equation - LQR steady state optimal control – Application examples.

At the end of the Module 4, students will be able to:

1. Understand the formulation of optimal control problem
2. Analyze the optimal control performance measures
3. Understand the Lyapunov and Matrix Riccati equations

**MODULE-5**

**OPTIMAL ESTIMATION:**
Introduction: Discrete systems - Optimal estimation: Kalman Filter, Kalman Bucy Filter, Solution by duality principle - Application examples.

**STABILITY ANALYSIS:**
Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems. Direct method of Lypanov for the Linear and Nonlinear continuous time autonomous systems.

At the end of the Module 5, students will be able to:

1. Analyze the operation of Kalman and Kalman Bucy Filter
2. Understand the Solution by duality principle
3. Understand the Direct method of Lypanov for autonomous systems.

**Total hours:** **50 hours**

**Term work:**
Assignments followed by quizzes

**Content beyond syllabus:**
Real-time Embedded Control Systems

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | state feedback controller and state observer | CO1 | https://nptel.ac.in/content/storage2/courses/108103008/PDF/module9/m9_lec3.pdf |
| 2 | linear and nonlinear systems using phase plane method | CO2 | https://nptel.ac.in/courses/108/106/108106162/ |
| 3 | Analysis of describing functions with non-linearities | CO3 | https://people.unica.it/eliousai/files/2015/10/Describing-Function-analysis-v1.pdf |
| 4 | Optimal control problem | CO4 | https://nptel.ac.in/courses/108/105/108105019/# |
| 5 | Solution of Kalman Filter by duality principle | CO5 | https://nptel.ac.in/content/storage2/courses/101108047/module15/Lecture%2040.pdf https://nptel.ac.in/courses/101/108/101108047/ |

**Text Book(s):**

1. M.Gopal, "Digital Control and State Variable Methods", 4th edition, Mc Graw Hill India, 2012
2. K. Ogata, 'Modern Control Engineering', 5th Edition, Pearson, 2012
3. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.

**Reference Book(s):**

1. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2011.
2. M.Gopal, Modern Control System Theory, 3rd edition, New Age International Publishers, 2014

**Online Resources:**

1. https://b-ok.asia/book/1193802/dec93b
2. https://b-ok.asia/book/459450/7e89ab

**Web Resources:**

1. https://www.youtube.com/watch?v=bbm79-UcNN0&list=PLbMVogVj5nJTNkhtkCEKQHhPOr2bpS3za
2. https://www.youtube.com/watch?v=DSvBXXnZv34&list=PLUY5PVaLSLNEKzeQv13ZevTL5AhnQOkWX

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4012 | Digital Signal Processing | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | ACS | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To Understand Discrete-time signals and systems & properties
2. To Understand z- Transform, inverse z- Transform & properties
3. To Understand the design of low pass, high pass, band pass & stop band IIR digital filters
4. To Understand Computer aided design of Equiripple Linear phase FIR filters
5. To Understand arithmetic round off errors, Low sensitivity digital filters

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand Discrete-time signals and systems & properties |
| **CO 2** | Analyze the z- Transform, inverse z- Transform & properties |
| **CO 3** | Understand the design of low pass, high pass, band pass & stop band IIR digital filters |
| **CO 4** | Learn Computer aided design of Equiripple Linear phase FIR filters |
| **CO 5** | Understand arithmetic round off errors, Low sensitivity digital filters. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 2 | 2 | 1 | | | | | | | | | | 1 | 2 |
| **CO2** | 1 | | 3 | | | | | | | | | | 1 | 2 |
| **CO3** | 2 | 2 | | | | | | | | | | | | 1 |
| **CO4** | 2 | 1 | 3 | | | | | | | | | | 1 | 2 |
| **CO5** | 2 | | 1 | | | | | | | | | | | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

Short introduction, Analog to digital and Digital to Analog conversion, sampled and Hold circuit, Continuous time Fourier Transforms. Discrete-time signals and systems, Discrete-time Fourier transform- its properties and applications, Fast Fourier Transform (in time-domain and Frequency domain) , IDFT and its properties.

At the end of the Module 1, students will be able to:

1. Understand Analog to digital and Digital to Analog conversion
2. Analyze Discrete-time signals & Continuous time Fourier Transforms

**MODULE -2**

**z- Transforms**

Definition and properties, Rational z-transforms, Region of convergence of a rational z- Transform, The inverse z-Transform, Z-Transform properties, Computation of the convolution sum of finite length sequences, The transfer function

**Digital Filter Structures:** Block Diagram representation, Equivalent structures, Basic FIR Digital Filter structures, Basic IIR Digital Filter structures, Realization of Basic structures using MATLAB, All pass filters, Computational complexity of Digital filter structures.

At the end of the Module 2, students will be able to:

1. Understand the Digital Filter structures
2. Able to Compute of the convolution sum of finite length sequences
3. Able to form Basic structures using MATLAB

| MODULE-3 |
|---|
| **IIR Digital Filter Design:**<br>Preliminary considerations, Bilinear transformation method of IIR Filter design, Design of low pass IIR Digital filters, Design of High pass, Band pass and band stop IIR digital filters, Spectral Transformations of IIR filter, IIR digital filter design using MATLAB, Computer aided design of IIR digital filters. |
| At the end of the Module 3, students will be able to:<br>1. Able to design Computer aided IIR digital filters<br>2. Understand the concept Bilinear transformation |
| **MODULE-4** |
| **FIR Digital Filter Design:**<br>Preliminary considerations, FIR filter design based on windowed Fourier series, Computer aided design of Equiripple Linear phase FIR filters, Design of Minimum phase FIR filters, FIR digital filter design using MATLAB, Design of computationally efficient FIR digital filters. |
| At the end of the Module 4, students will be able to:<br>1. Understand the concept of windowed Fourier series<br>2. Analyze the Design of Minimum phase FIR filters |
| **MODULE-5** |
| **Analysis of Finite word length effects**:<br>The quantization process and errors, quantization of Fixed point numbers, Quantization of floating point numbers, Analysis of coefficient quantization effects, Analysis of arithmetic round off errors, Low sensitivity digital filters, Reduction of product round off errors using error feedback, Round off errors in FFT algorithms. The basic sample rate alteration devices, Multi rate structures for sampling rate conversion, Multistage design of decimator and interpolator, The Poly phase decomposition, Arbitrary-rate sampling rate converter. |
| At the end of the Module 5, students will be able to:<br>1. Analyze the coefficient quantization effects<br>2. Understand the Multi rate structures for sampling rate conversion<br>3. Understand the Multistage design of decimator and interpolator. |
| **Total hours: 50 hours** |

**Term work:**
Assignments followed by quizzes

**Content beyond syllabus:**
Nyquist Filters and some applications of digital signal processing.

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Discrete-time Fourier transform- its properties | CO1 | https://cnx.org/contents/KilsjSQd@10.18:AMguPRlV@11/Properties-of-the-DTFT |
| 2 | Basic FIR Digital Filter structures | CO2 | https://www.ni.com/docs/en-US/bundle/labview-2014-digital-filter-design-toolkit-api-ref/page/lvdfdtconcepts/fir_filter_specs.html |
| 3 | Computer aided design of IIR digital filters. | CO3 | https://www.tutorialspoint.com/digital_signal_processing/dsp_computer_aided_design.htm |
| 4 | Design of Minimum phase FIR filters | CO4 | https://www.dsprelated.com/freebooks/filters/Minimum_Phase_Filters.html |
| 5 | Analysis of arithmetic round off errors | CO5 | https://en.wikipedia.org/wiki/Round-off_error |

**Text Book(s):**

1. S.K. Mitra, Digital Signal Processing-, Tata McGraw-Hill, Third Edition, 2006.
2. B.P. Lathi, Principle of Signal Processing and Linear Systems-, Oxford International Student Version, 2009
3. M. Mondal and A Asif, Continuous and Discrete Time Signals and Systems, Cambridge,2007

**Reference Book(s):**

1. Li Tan, Digital Signal Processing- Fundamentals and Applications-, Indian reprint, Elsevier, 2008.
2. Alan V. Oppenheim, Ronald W. Schafer, and John R.Buck, Discrete- Time Signal Processing-, Pearson Edu, 2008.

**Online Resources:**

1. https://www.tutorialspoint.com/digital_signal_processing/dsp_unstable_systems.htm
2.softwaretestinghelp.com/digital-signal-processing-tutorial/

**Web Resources:**

1. https://www.youtube.com/watch?v=6dFnpz_AEyA
2. https://www.youtube.com/watch?v=JpHXMcDxNiA
3.https://www.youtube.com/watch?v=p8cina5Ke_c

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4017 | MULTIVARIABLE CONTROL SYSTEMS | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | ACS | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To Understand Multivariable Connections, Multivariable Representation
2. To Understand Performance Specification in Multivariable Systems
3. To Understand Stability of Multivariable Feedback
4. To Understand Controllability and Observability and Realization in Multivariable Systems
5. To Understand Multivariable Control System Design

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Learn the Multivariable Connections, Multivariable Representation |
| **CO 2** | Analyze the Performance Specification in Multivariable Systems. |
| **CO 3** | Analyse Stability of Multivariable Feedback |
| **CO 4** | Learn the Controllability and Observability and Realization in Multivariable Systems |
| **CO 5** | Understand the Multivariable Control System Design |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 1 | 1 | | | | | | | | | | 1 | 2 |
| CO2 | 3 | | 1 | | | | | | | | | | 1 | 1 |
| CO3 | 1 | 2 | | | | | | | | | | | | 1 |
| CO4 | 2 | 2 | 3 | | | | | | | | | | 1 | 2 |
| CO5 | 2 | | 1 | | | | | | | | | | | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**Introduction in Multivariable Control Systems:**
Multivariable Connections, Multivariable Representation
**Poles and Zeros in Multivariable Systems** : Multivariable Poles and Zeros, Direction of Poles and Zeros, Smith-McMillan Form, Matrix Fraction Description, Transmission Zero Assignment

At the end of the Module 1, students will be able to:

1. Understand the Multivariable Control Systems
2. Analyze the Transmission Zero Assignment

**MODULE -2**

**Performance Specification in Mulivariable Systems and Their Limitations:**
A Brief Review of Linear Control System, Scaling and Performance, Shaping Closed-loop Transfer Function, Fundamental Limitation on Performance

At the end of the Module 2, students will be able to:

1. Understand the Performance Specification in Mulivariable Systems
2. Understand the Limitations

**MODULE-3**

| |
|---|
| **Stability of Multivariable Feedback Control Systems:** Well-Posedness of Feedback Loop, Internal Stability, The Nyquist Stability Criterion, Co-prime Factorization over Stable Transfer Functions, Stabilizing Controllers, Strong and Simultaneous Stabilization |
| At the end of the Module 3, students will be able to:<br>1. Understand the concept of Stabilizing Controllers<br>2. Understand the concept of Stability |
| **MODULE-4** |
| **Controllability and Observability and Realization in Multivariable Systems:**<br><br>Controllability and Observability, Output Controllability, Realization, Model Order Reduction |
| At the end of the Module 4, students will be able to:<br>1. Understand the concept of Controllability and Observability<br>2. Analyze the Realization techniques |
| **MODULE-5** |
| **Multivariable Control System Design**: Sequential Loop Closing, Characteristic-Locus Method, PI Controller for MIMO Systems ,Decoupling, Diagonal Controller, Nyquist-Array Method |
| At the end of the Module 5, students will be able to:<br>1. Analyze the Sequential Loop Closing<br>2. Understand the Decoupling, Diagonal Controllers |

| | |
|---|---|
| **Total hours:** | **50 hours** |

**Term work:**
Assignments followed by quizzes

**Content beyond syllabus:**
Robust stability and performance analysis via integral quadratic constraints.

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Multivariable Control Systems | CO1 | https://www.youtube.com/watch?v=mMtFuYeJp5A |
| 2 | Scaling and Performance ns | CO2 | https://www.dynatrace.com/news/blog/performance-vs-scalability/ |
| 3 | Stability of Multivariable Feedback Control Systems | CO3 | https://www.sciencedirect.com/topics/engineering/multivariable-control-systems |
| 4 | Model Order Reduction | CO4 | https://www.hindawi.com/journals/sv/2021/6631180/ |
| 5 | Controllability and Observability and Realization in Multivariable Systems | CO5 | http://profsite.um.ac.ir/~karimpor/multi/Multivariable_lec5.pdf |

| |
|---|
| **Text Book(s):**<br>**1.Multivariable Control Systems: An Engineering Approach (Advanced Textbooks in Control and Signal Processing) 2004th Edition, Kindle Edition by Pedro Albertos (Author), Sala Antonio (Author) Format: Kindle Edition** |
| **Reference Book(s):**<br>1. Multivariable Feedback Control - Analysis and Design 2e (English, Paperback, Skogestad S) |
| **Online Resources:**<br>1. https://research.iaun.ac.ir/pd/mahmoodian/pdfs/UploadFile_3352.pdf |
| **Web Resources:**<br>1. https://research.iaun.ac.ir/pd/mahmoodian/pdfs/UploadFile_3352.pdf |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4022 | REAL TIME CONTROL SYSTEMS | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | ACS | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To Understand Real - time systems
2. To Understand Hierarchical representation of complex DES
3. To Understand Real - time Operating Systems, Interrupts
4. To Understand Real – time Programming.
5. To Understand Real - time process and applications

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Analyze the Characteristic features of RT applications and develop features from Non - RT and Off - line system |
| **CO 2** | Understand the Hierarchical representation and analyzing Logical properties |
| **CO 3** | Derive the Example of checking safety and timing properties and also understand the Requirements and features of real - time Computing Environments |
| **CO 4** | Understand and analyze the Real – time Programming for real-time systems. |
| **CO 5** | Analyze the Real - time process, Applications and understand the Distributed Real - time systems |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 3 | 2 | 2 | | | | | | | | | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | | | | | | | | | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | | | | | | | | | | 1 |
| **CO4** | 3 | 3 | 2 | 2 | | | | | | | | | 1 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | | | | | | | | | | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

Introduction to Real - time systems: Typical examples of RTS, Characteristic features of RT Applications. Structural, Functional and Performance requirement of Reactive RTS. Distinctive Features from Non - RT and Off - line system. Modelling RTS: Representation of time, Concurrency and Distributedness in discrete event systems.

At the end of the Module 1, students will be able to:

1. Understand the Real - time systems
2. Analyze the Characteristic features of RT applications
3. Develop features from Non - RT and Off - line system

**MODULE -2**

Hierarchical representation of complex DES. Input, Output and Communication. Examples of Modelling practical systems as RT DES. Modelling programs as RTS. Analyzing RTS: Analyzing Logical properties of DES such as Reachability, Deadlock etc. Analyzing timing related properties, Specification and Verification of RT DES properties.

At the end of the Module 2, students will be able to:

1. Understand the Hierarchical representation
2. Analyzing Logical properties

**MODULE-3**

| |
|---|
| Temporal logic, Model checking of industrial systems. Requirements and features of real - time Computing Environments: Real - time Operating Systems, Interrupts, clock, Device support. |
| At the end of the Module 3, students will be able to:<br>1. Derive the Example of checking safety and timing properties.<br>2. Understand the Requirements and features of real - time Computing Environments |
| **MODULE-4** |
| Real time System, Multi tasking, Static and Dynamical Scheduling of resource Allocation, Real – time Programming. |
| At the end of the Module 4, students will be able to:<br>1. Understand the Real time System<br>2. Analyze the Real – time Programming. |
| **MODULE-5** |
| Real - time process and applications, Distributed Real - time systems. |
| At the end of the Module 5, students will be able to:<br>1. Analyze the Real - time process<br>2. Understand the Real - time Applications<br>3. Understand the Distributed Real - time systems |
| **Total hours: 48 hours** |

**Term work:**
Assignments followed by quizzes

**Content beyond syllabus:**
Dynamic Scheduling Algorithms

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Distributedness in discrete event systems | CO1 | https://www.intechopen.com/chapters/38818 |
| 2 | Specification and Verification of RT DES properties | CO2 | https://hal.archives-ouvertes.fr/hal-01589479/document |
| 3 | Requirements and features of real - time Computing Environments | CO3 | https://www.sciencedirect.com/topics/computer-science/real-time-computing |
| 4 | Multi tasking of Real time System | CO4 | https://www.razorrobotics.com/multitasking-real-time-operating-systems/ |
| 5 | Distributed Real - time systems | CO5 | https://link.springer.com/book/10.1007/978-3-030-22570-4 |

**Text Book(s):**
1. Jane W S Liu, "Real- Time Systems", Pearson publications, 1st edition, 2006.

**Reference Book(s):**
**1.** Rajib Mall**, "**R
eal-Time Systems: Theory and Practice", Pearson Education India**,** 2009.

| |
|---|
| **Online Resources:**<br>1. https://www.intechopen.com/chapters/38818<br>2. https://hal.archives-ouvertes.fr/hal-01589479/document<br>3. https://www.sciencedirect.com/topics/computer-science/real-time-computing<br>4. https://www.razorrobotics.com/multitasking-real-time-operating-systems/<br>**5.** https://link.springer.com/book/10.1007/978-3-030-22570-4 |
| **Web Resources:**<br>1. https://onlinecourses.nptel.ac.in/noc21_cs98/preview |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4003 | MACHINE MODELING AND ANALYSIS | | | | | | | R2021 |
| | Hours / Week | | | Total | Credit | Max Marks | | |
| | L | T | P | **hrs** | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Fundamental concepts of Electrical Machines and Electro Magnetic Fields.

**Course Objectives:**

Able to understand the

1. Able to analyze the Basic Concepts of Modeling Electrical machines.
2. To understand Mathematical model of the DC Motor.
3. Able to analyze the dynamic modeling and phase transformation.
4. To understand the Modeling of Induction Machine.
5. To understand the Dynamic Analysis of Synchronous Machine.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the basic concepts of AC/ DC machine modeling. (BL-2) |
| **CO 2** | Understand the Mathematical model of the DC Machine. (BL-2) |
| **CO 3** | Analyze the Reference frame theory model of Electrical machine.(BL-3) |
| **CO 4** | Analyze the steady state and dynamic state operation of three-phase induction machine.(BL-3) |
| **CO 5** | Analyze the modeling and simulation of three phase synchronous machine .(BL-3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 2 | 2 | 2 | | 2 | | | | | | | 1 | 3 |
| **CO2** | 2 | 2 | 2 | | | | | | | | | | 2 | 3 |
| **CO3** | 2 | 2 | 2 | | | 2 | | | | | | | 2 | 3 |
| **CO4** | 3 | 2 | | | | | | | | | | | 2 | 3 |
| **CO5** | 2 | 3 | | | | 2 | | | | | | | 1 | 3 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| **MODULE – 1** | **BASIC CONCEPTS OF MODELING** | **08 Hours** |
|---|---|---|

Basic Two - pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine - voltage, current and Torque equations.

At the end of the Module 1, students will be able to:

1. Understand the Two - pole Machine representation of Commutator machines. (BL-2)
2. Study the Kron's primitive Machine. (BL-2)
3. Understand the voltage, current and Torque equations. (BL-2)

| **MODULE -2** | **MODELING OF DC MACHINES** | **08 Hours** |
|---|---|---|

Mathematical model of separately excited D.C motor –Steady State analysis - Transient State analysis - Sudden application of Inertia Load - Transfer function of Separately excited D.C Motor - Mathematical model of D.C Series motor, Shunt motor - Linearization Techniques for small perturbations.

| | | |
|---|---|---|
| At the end of the Module 2, students will be able to:<br>1. Compare the Mathematical model of Different of DC Motors. (BL-2)<br>2. Explain the Steady State analysis. (BL-2)<br>3. Understand the Linearization Techniques for small perturbations. (BL-2) | | |
| **MODULE-3** | **REFERENCE FRAME THEORY** | **08 Hours** |
| Reference frame theory Real time model of a two phase induction machine - three phase to two phase transformation - Dynamic modeling of three phase Induction Machine - Stator reference frame model - Rotor reference frame model Synchronously rotating reference frame model. | | |
| At the end of the Module 3, students will be able to:<br>1. Understand the Real time model of a two phase induction machine. (BL-2)<br>2. Explain the three phase to two phase transformation. (BL-2)<br>3. Understand the Stator and Rotor reference frame model. (BL-2) | | |
| **MODULE-4** | **MODELING OF INDUCTION MACHINES** | **08 Hours** |
| Three phase induction machine, equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary Reference frame variables – analysis of dynamic performance for load torque variations. | | |
| At the end of the Module 4, students will be able to:<br>1. Demonstrate on steady state operation of induction machine. (BL-2)<br>2. Understand the voltage and torque equations in induction machines. (BL-2)<br>3. Analysis of dynamic performance of induction machines. (BL-3) | | |
| **MODULE-5** | **MODELING AND ANALYSIS OF SYNCHRONOUS MACHINES** | **08 Hours** |
| Synchronous machine inductances – voltage equations in the rotor's dq0 reference frame - electromagnetic torque - current in terms of flux linkages - simulation of three phase synchronous machine.<br>Dynamic performance of synchronous machine, three -phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria. | | |
| At the end of the Module 5, students will be able to:<br>1. Understand the electromagnetic torque.(BL-2)<br>2. Explain the Synchronous machine inductances. (BL-2)<br>3. Demonstrate on simulation of three phase synchronous machine.(BL-2) | | |
| | **Total hours:** | **40 hours** |

**Term work:**

1. Compare and Contrast the Mathematical model of different types of DC Motors submit the report.
2. Compare and Contrast the 3 phase synchronous machine with and without damper bars and submit the report.
3. Analyze the two phase induction machine and three phase induction machine and submit the report.
4. Analyze the Synchronous motor and PM Synchronous motor and submit the report.

**Content beyond syllabus:**

1. Symmetrical Two phase Induction Machine.
2. Unsymmetrical Two phase Induction Machine.
3. Modeling of PM Synchronous motor.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Module | Reference |
|---|---|---|
| 1 | BASIC CONCEPTS OF MODELING | https://nptel.ac.in/courses/112/107/112107220/ |
| 2 | MODELING OF DC MACHINES | https://nptel.ac.in/courses/108/106/108106023/ |
| 3 | REFERENCE FRAME THEORY | http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php |
| 4 | MODELING OF INDUCTION MACHINES | https://nptel.ac.in/courses/108/106/108106023/ |
| 5 | MODELING AND ANALYSIS OF SYNCHRONOUS MACHINES | https://nptel.ac.in/courses/108/101/108101004/ |
| 6 | DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINES | https://nptel.ac.in/courses/108/106/108106023/ |

**Text Book(s):**


1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis & Control", PHI Learning Private Ltd, 2009.
2. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.
2. Sawhney, A.K., "A Course in Electrical Machine Design", Dhanpat Rai & Sons, New Delhi, 2013.


**Reference Book(s):**


1. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 5th Edition, 2014.
2. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, "Electric Machinery", Tata McGraw Hill, 5th Edition, 1992.
3. Chee Mun Ong –"Dynamic simulation of Electric machinery using MATLAB / Simulink", Prentice Hall of India Publications.
4. Ramamoorthy M, "Computer Aided Design of Electrical Equipment", East-West Press.


**Online Resources/ Web References:**

1. https://books.google.co.in/books?id=0_D6gfUHjcEC&printsec=frontcover#v=onepage&q&f=false
2. http://nptel.ac.in/courses/108106023/
3. https://easyengineering.net/electrical-machinery-by-bimbhra/
4. https://www.hindawi.com/journals/mpe/2017/7348263/
5. https://nptel.ac.in/courses/108/106/108106023/
6. https://nptel.ac.in/courses/108/102/108102146/
7. http://www.ijrimsec.com/assoc_art/volume7_1/Ch_10.pdf
8. https://nptel.ac.in/courses/108/106/108106023/#

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4008 | **Electrical Machine Design** | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Basic Electrical Engineering, DC Machines, Induction machines, Transformers and Synchronous machines**

**Course Objectives:**

1. To discuss the properties of electrical, magnetic and insulating materials used in the design of electrical machines.
2. To design armature and field systems for D.C. machines.
3. To design core, yoke, windings and cooling systems of transformers.
4. To design stator and rotor of induction machines.
5. To design stator and rotor of synchronous machines and study their thermal behavior.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the basic principles of machine design. (BL-2) |
| **CO 2** | Analyze the performance design DC motor. (BL-4) |
| **CO 3** | Analyze the performance design winding and core of transformer. (BL-4) |
| **CO 4** | Analyze the performance design winding and core of rotating electrical machine. (BL-4) |
| **CO 5** | Analyze the short circuit ratio and its effects on performance of synchronous machines. (BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | | | | | | | | | | |
| CO2 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |
| CO3 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |
| CO4 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |
| CO5 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | PRINCIPLES OF ELECTRICAL MACHINE DESIGN | 8Hrs |
|---|---|---|

Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines.

At the end of the Module 1, students will be able to:

1. Understand the limitations of electrical machines. . (BL-2)
2. Understand the different types of material used in electrical machines. (BL-2)
3. Understand the different types of Insulators used in electrical Machines. (BL-2)

| MODULE -2 | DESIGN OF DC MACHINES | 10Hrs |
|---|---|---|

Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and poles- main and inter poles, field windings – shunt, series and inter poles.

| | | |
|---|---|---|
| At the end of the Module 2, students will be able to:<br>1. Explain the output equation of DC machine. (BL-2)<br>2. Explain the choice of specific loadings for DC machine. (BL-2)<br>3. Understand the design of main dimension of DC machine and Design of armature slot, commutator yoke and pole. (BL-2) | | |
| **MODULE-3** | **DESIGN OF TRANSFORMERS** | **10Hrs** |
| Output Equations for single phase and three phase transformers, expression for volts/turn, Main Dimensions, Window space factor, Design of core and winding, Overall dimensions , expression for leakage reactance and voltage regulation, No load current , Temperature rise in Transformers ,Design of Tank, Methods of cooling of Transformers. | | |
| At the end of the Module 3, students will be able to:<br>1. Understand the main dimensions of transformers. (BL-2)<br>2. Understand the calculation of no load current.(BL-2)<br>3. Understand the design of transformer tank. (BL-2) | | |
| **MODULE-4** | **Design of Induction Motors** | **10Hrs** |
| Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance of single phase and Three Phase Induction motor. | | |
| At the end of the Module 4, students will be able to:<br>1. Understand the specific loadings and main dimensions of single phase and three phase induction motor. (BL-2)<br>2. Understand the design of slip ring and squirrel cage rotor. (BL-2)<br>3. Understand the Design of end rings and slip rings. (BL-2) | | |
| **MODULE-5** | **Design of Three Phase Synchronous Machines** | **10Hrs** |
| Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding. | | |
| At the end of the Module 6, students will be able to:<br>1. Understand the output equation of synchronous machines. (BL-2)<br>2. Understand the knowledge applied by designing a machine for an industrial application. (BL-2)<br>3. Explain the Magnetic Circuit and Field Winding of a synchronous machine. (BL-2) | | |
| | **Total hours:** | **48 hours** |

**Term work:**

1. Field trip visit at Voltactive Power Technologies Pvt Ltd Vijayawada to understand the design of transformer .
2. Develop armature winding diagram for DC and AC machines Develop a layout for substation using the standard symbols for substation equipment through Auto CADD
3. Draw sectional views of core and shell types transformers using the design data through Auto CADD
4. Draw sectional views of assembled DC machine or its parts using the design data or the sketches through Auto CADD.

**Content beyond syllabus:**

1. Design of small transformer
2. Modelling Of Electro Static and Magnetic Device.

**3.** Estimation of material and electrical installation of motor in different industry

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | Reference |
|---|---|---|
| 1 | Principles Of Electrical Machine Design | http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php |
| 2 | Design of DC Machines | https://nptel.ac.in/courses/108/106/108106023/ |
| 3 | Design of Transformers | http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php |
| 4 | Design of Induction Motors | https://nptel.ac.in/courses/108/106/108106023/ https://nptel.ac.in/courses/108/106/108106023/ |
| 5 | Design of Three Phase Synchronous Machines | https://nptel.ac.in/courses/108/106/108106023/ |

**Text Book(s):**

1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, 2011.
2. M.V.Deshpande "Design and Testing of Electrical Machine Design" Wheeler Publications, 2010.
3. V.N. Mittle and A. Mittle, "Design of Electrical Machines", 5th Edition, Standard Publications and Distributors, 2014, New Delhi.

**Reference Book(s):**

1. A.Shanmuga Sundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.
2. R.K.Agarwal " Principles of Electrical Machine Design" Esskay Publications, 5th Edition Delhi, 2014.
3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987
4. Ramamoorthy M, "Computer Aided Design of Electrical Equipment", East-West Press.
5. M. N. O. Sadiku, " Numerical techniques in Electromagnetics", CRC Press Edition-2001.
6. M.V. Deshpande, "Design and Testing of Electrical Machines"PHI learning, New Delhi.

**Online Resources:**

https://nptel.ac.in/courses/108/106/108106023/

**Web Resources:**

http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php

JuhaPyrhonen, TapaniJokinen, Valeria Hrabovcova "Design of Rotating Electrical Machines", ISBN: 978-0-470-69516-6. Willey Publication Hardcover. 538 pages. February 2009. .

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4013 | **Programmable Control Devices and Applications** | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite**: To Learn about Power Electronic devices, Semiconductor drives, Energy storage systems( Battery, Fuel Cell, Super Capacitor etc).

**Course Objectives:**

1. Understand the basic functions and types of PLCs.
2. Get exposure of Easy Veep software, its applications.
3. Classification of PLCs and applications
4. Programming using PLCs .
5. Troubleshooting aspects using PLCs.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand different types of PLCs (BL-2) |
| **CO 2** | Understand the usage of Easy Veep software (BL-1) |
| **CO 3** | Understand the hardware details of Allen Bradley PLC . (BL-2) |
| **CO 4** | Programming of PLCs . (BL-2) |
| **CO 5** | Know about few applications of PLCs in different fields of Science and Technology . (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | | | 2 | | | | | | 2 | 3 |
| CO2 | 2 | | | | | | | | | | | | 2 | 2 |
| CO3 | 3 | | 1 | | | | | | | | | | 1 | 2 |
| CO4 | 2 | | | | | | | | | | | | 1 | |
| CO5 | 2 | | | | | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | INTRODUCTION | 8 Hours |
|---|---|---|

Basic functions of PLCs, Mechanical relays versus PLC, Different types of PLC's – AllenBradley – Micrologix: ML1000, ML1100, SLC500, Compact Logix, Mitsubishi FX series, HMI's, Processor and I/O cards.

At the end of the Module 1, students will be able to:

1. To understand about basic functions of PLCs. (BL-2)
2. To distinguish between PLCs and Mechanical relays. (BL-2)
3. To know about Processor and I/O cards. (BL-2)

| MODULE -2 | Logic diagrams | 8 Hours |
|---|---|---|

Introduction to Easy Veep software, Link between mechanical, electrical and programming documentation, Logic diagrams, Flip-Flop Logic, M8000, M8001 internal bits interpretation, Binary code, data table, manipulation.

| | | |
|---|---|---|
| At the end of the Module 2, students will be able to:<br>1. To know about Easy Veep software .(BL-1)<br>2. To know about Logic diagrams. (BL-2) | | |
| **MODULE-3** | **PLC software and applications** | **8 Hours** |
| PLC software and applications, Boolean algebra – understanding binary code, ADD and SUB functions, UP and Down Counters, Introduction to k1Y0, MOV function, CPR and ZCP functions, SHWT and SHRD instructions, Introduction to Absolutely Drum Instruction. | | |
| At the end of the Module 3, students will be able to:<br>1. To know about basic features of PLCs. (BL-2)<br>2. To know about various instructions of PLC. (BL-2) | | |
| **MODULE-4** | **PLC Hardware** | **10 Hours** |
| Allen Bradley PLC: Introduction to Rockwell Software, Hardware focus, Hardware considerations (Field wiring, Master Control Relay, VFD), Basic programming and applications, Cascade control – subroutine, Different programs. | | |
| At the end of the Module 4, students will be able to:<br>1. To know about various PLC versions. (BL-2)<br>2. To understand about Cascade control and subroutines. (BL-1) | | |
| **MODULE-5** | **PLC IC applications** | **10 Hours** |
| Programming instructions: Instructions and binary interpretation, Bit Instruction, Timers and counters, Comparison instructions, Programming Instructions - Math instructions, Move and Logical Instructions, Discussions of programming, communications for PLC-Robotic arm, Exercise of setup and monitoring. | | |
| At the end of the Module 6, students will be able to:<br>1. To know about various Programming instructions. (BL-1)<br>2. To understand Math instructions in PLCs. (BL-2)<br>3. To understand about Communications with PLC using set up and monitoring. (BL-2) | | |
| | **Total hours:** | **44 hours** |

**Term work:**

Term work contains minimum two group assignments followed by seminars and quiz's

**Content beyond syllabus:**

1. Hybridization of different energy storage devices
2. Mechanics of Electric Vehicles

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Introduction to PLC | CO1 | https://www.youtube.com/watch?v=PbAGl_mv5XI |
| 2 | PLC logic circuits | CO2 | https://www.youtube.com/watch?v=X3xGqdb0DAA |
| 3 | PLC software applications | CO3 | https://www.youtube.com/results?search_query=PLC+software+ |

| | | | | |
|---|---|---|---|---|
| | 4 | PLC Hardware applications | CO4 | https://www.youtube.com/results?search_query=plc+hardware+components |
| | 5 | PLC IC applications | CO5 | https://www.youtube.com/watch?v=JvTCgq5vss0 |

**Text Book(s):**

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. Electric Vehicle Technology Explained-James Larminie, John Lowry-John Wiley & Sons Ltd,-2003
4. Electric & Hybrid Vehicles-Design Fundamentals-Iqbal Hussain, Second Edition, CRCPress,2011

**Reference Book(s):**

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
2. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.
3. Iqbal Husain, "Electric and Hybrid Electric Vehicles", CRC Press, 2011.
4. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, WILEY, 2017

**Online Resources / Web References:**

1. https://b-ok.asia/book/1226776/eceb4b
2. https://b-ok.asia/book/3357286/21e776
3. http://ceb.ac.in/knowledge-center/E-BOOKS/Modern%20Electric,%20Hybrid%20Electric%20&%20Fuel%20Cell%20Vehicles%20-%20Mehrdad%20Ehsani.pdf
4. https://b-ok.asia/book/3516646/6fe038
5. https://nptel.ac.in/courses/108/103/108103009/
6. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl
7. https://www.youtube.com/watch?v=11e_d3Q9jEc

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4018 | HYBRID ELECTRICAL VEHICLES | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite**: To Learn about Power Electronic devices, Semiconductor drives, Energy storage systems( Battery, Fuel Cell, Super Capacitor etc).

**Course Objectives:**

1. To understand Importance of Hybrid Electric Vehicles
2. To Know the various drive-train topologies
3. To Learn the operation and configurations of DC & AC Drives
4. To Know the importance of various Energy storage systems and Energy management strategies
5. To provide knowledge about supervisory control of EVs

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the models to describe hybrid vehicles and their performance (BL-2) |
| **CO 2** | Classify various hybrid drive-train topologies(BL-1) |
| **CO 3** | Understand the various configurations of DC & AC Motor drives. (BL-2) |
| **CO 4** | Understand the different possible ways of energy storage and different strategies related to Energy management strategies. (BL-2) |
| **CO 5** | Understand the mode of operation and control Architecture. (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | | | 2 | | | | | | 2 | 3 |
| CO2 | 2 | | | | | | | | | | | | 2 | 2 |
| CO3 | 3 | | 1 | | | | | | | | | | 1 | 2 |
| CO4 | 2 | | | | | | | | | | | | 1 | |
| CO5 | 2 | | | | | | | | | | | | 1 | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | INTRODUCTION TO ELECTRIC VEHICLES | 8 Hours |
|---|---|---|

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

At the end of the Module 1, students will be able to:

1. Understand the importance of Electric vehicles over Conventional vehicles. (BL-2)
2. Understand the social and environmental importance of hybrid and electric vehicles. (BL-2)
3. Understand the impact of modern drive-trains on energy supplies. (BL-2)

| MODULE -2 | Hybrid Electric Drive-trains | 8 Hours |
|---|---|---|
| Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis | | |
| At the end of the Module 2, students will be able to:<br>1. Compare various hybrid drive-train topologies. (BL-1)<br>2. Explain power flow control in hybrid drive-train topologies. (BL-2)<br>3. Understand the Fuel efficiency analysis. (BL-2) | | |
| **MODULE-3** | **Electric Propulsion unit** | **8 Hours** |
| Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives | | |
| At the end of the Module 3, students will be able to:<br>1. Understand Configuration of DC Motor drives. (BL-2)<br>2. Understand Configuration of Induction Motor drives. (BL-2)<br>3. Understand Configuration of SRM drives. (BL-2) | | |
| **MODULE-4** | **Energy Storage Systems and Energy Management** | **10 Hours** |
| Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery, Fuel Cell, Super Capacitor based energy storage and its analysis.<br>Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies. | | |
| At the end of the Module 4, students will be able to:<br>1. Understand the requirements of Energy storage systems. (BL-2)<br>2. Know the Battery based Energy storage systems. (BL-1)<br>3. Understand the importance of energy management strategies. (BL-2) | | |
| **MODULE-5** | **Hybrid Vehicle Control Strategy** | **10 Hours** |
| HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode. | | |
| At the end of the Module 6, students will be able to:<br>1. Know the speed control techniques of HEV. (BL-1)<br>2. Distinguish the different modes of operation of control strategies. (BL-2) | | |
| | **Total hours:** | **44 hours** |

**Term work:**

Term work contains minimum two group assignments followed by seminars and quiz's

**Content beyond syllabus:**

1. Hybridization of different energy storage devices
2. Mechanics of Electric Vehicles

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Introduction to | CO1 | https://nptel.ac.in/content/storage2/courses/108103009/ |

| | | | | |
|---|---|---|---|---|
| | | Electric Vehicles | | download/M1.pdf<br>https://www.youtube.com/watch?v=KOLBGKMo3zQ |
| | 2 | Hybrid Electric Drive-trains | CO2 | https://www.youtube.com/watch?v=oydKVcJqPQ0<br>https://nptel.ac.in/content/storage2/courses/108103009/download/M3.pdf |
| | 3 | DC & AC Motor drives | CO3 | https://www.youtube.com/watch?v=1AT1yuQ9awM&list=PLFW6lRTa1g83sIfVY1p1xGqPGYUmXyahx |
| | 4 | Energy Storage Systems & Energy Management Strategies | CO4 | https://www.youtube.com/watch?v=j7RaL_XKywk<br>https://nptel.ac.in/content/storage2/courses/108103009/download/M10.pdf |
| | 5 | Hybrid Vehicle Control Strategy | CO5 | https://nptel.ac.in/content/storage2/courses/108103009/download/M12.pdf |

**Text Book(s):**

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. Electric Vehicle Technology Explained-James Larminie, John Lowry-John Wiley & Sons Ltd,-2003
4. Electric & Hybrid Vehicles-Design Fundamentals-Iqbal Hussain, Second Edition, CRCPress,2011

**Reference Book(s):**

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
2. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.
3. Iqbal Husain, "Electric and Hybrid Electric Vehicles", CRC Press, 2011.
4. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, WILEY, 2017

**Online Resources / Web References:**

1. https://b-ok.asia/book/1226776/eceb4b
2. https://b-ok.asia/book/3357286/21e776
3. http://ceb.ac.in/knowledge-center/E-BOOKS/Modern%20Electric,%20Hybrid%20Electric%20&%20Fuel%20Cell%20Vehicles%20-%20Mehrdad%20Ehsani.pdf
4. https://b-ok.asia/book/3516646/6fe038
5. https://nptel.ac.in/courses/108/103/108103009/
6. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl
7. https://www.youtube.com/watch?v=11e_d3Q9jEc

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4023 | AUTOMOTIVE ELECTRICAL ENGINEERING | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | AEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the various types of Batteries and their ratings
2. To understand the starting condition and its behavior
3. To understand the various charging systems in Automobiles
4. To learn different Lighting systems in Automobiles
5. To learn electronic engine management system in Automobiles
6. To understand the various electrical and non electrical sensors

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Compute the efficiency of Batteries through various test's |
| **CO 2** | Understand the working of different starter drive units and their maintenance and the concept of vehicle charging system with its auxiliaries |
| **CO 3** | Understand the dazzling of head light and its preventive methods |
| **CO 4** | Understand the electronic dashboard instruments & onboard diagnostic system |
| **CO 5** | Understand the various sensors used in Automobiles |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | | 1 | | | | 2 | | | | | | 2 | 2 |
| CO2 | 2 | 1 | 1 | | | | | | | | | | | |
| CO3 | 2 | | 1 | | | | | | | | | | 1 | |
| CO4 | 2 | 1 | 2 | | | | | | | | | | 2 | 2 |
| CO5 | 2 | 1 | 1 | | | | | | | | | | 1 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | 10 Hours |
|---|---|

**BATTERIES ACCESSORIES AND CHARGING SYSTEM**

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging.
Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout. Voltage and current regulators, compensated voltage regulator, alternators.

At the end of the Module 1, students will be able to:

1. Explain the Principle and construction of lead acid battery
2. Identify the ratings of various Batteries
3. Understand the importance of voltage and current regulators in charging system

| MODULE -2 | 10 Hours |
|---|---|

**STARTING SYSTEM**

Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, starter switches.

At the end of the Module 2, students will be able to:

1. Understand the importance of starter
2. Understand the principle and construction of starter motor
3. Explain the various types of starter switches

| MODULE-3 | 10 Hours |
|---|---|

**LIGHTING**

Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods – Horn, wiper system and trafficator.

At the end of the Module 4, students will be able to:

1. Understand the arrangement of insulated and earth return system
2. Understand the working of wiper system and trafficator.

| MODULE-4 | 10 Hours |
|---|---|

**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS**

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

At the end of the Module 5, students will be able to:

1. Understand the use of electronics in engine management system
2. Understand the concept of electromagnetic interference suppression
3. Understand the Automobile security and warning system

| MODULE-5 | 10 Hours |
|---|---|

**SENSORS AND ACTUATORS**

Types of sensors: sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay.

At the end of the Module 6, students will be able to:

1. Identify various types of sensors in Automobiles
2. Explain about air mass flow in engine application

| Total hours: | 50 hours |
|---|---|

**Term work:**

Individual Assignments, followed by Quiz's

**Content beyond syllabus:**

1. Advanced charging system in Automobiles

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Construction of lead acid battery | CO1 | https://circuitglobe.com/lead-acid-battery.html https://www.howacarworks.com/basics/how-the-charging-system-works |
| 2 | Principle and construction of starter motor | CO2 | https://www.samarins.com/glossary/starter.html |
| 3 | Lighting system | CO3 | https://what-when-how.com/automobile/lighting-circuit-automobile/ |
| 4 | Automotive electronic engine management system | CO4 | https://www.ukessays.com/essays/engineering/electronic-control-unit-and-engine-management-system-engineering-essay.php |
| 5 | Types of sensors | CO5 | https://www.my-cardictionary.com/electronics/sensors.html |

**Text Book(s):**

1. Tom Weather Jr and Cland C.Hunter, *"Automotive Computers and Control system"*, Prentice Hall Inc., New Jersey.
2. A. Bonnick, *"Automotive Computer Controlled Systems"*, 2011.
3. Young A. P & Griffiths L, *"Automobile Electrical and Electronic Equipments"* English Languages Book Society & New Press, 1990.

**Reference Book(s):**

1. Santini Al, *"Automotive Electricity and Electronics"*, Cengage Learning, 2012.
2. Tom Denton, *"Automotive Electrical and Electronic System"*, SAE International, 2004.
3. William B. Ribbens, *"Understanding Automotive Electronics"*, 6th Edition, Newnes, 2003.
4. BOSCH, *"Automotive Handbook"*, 8th Edition, BENTLEY ROBERT Incorporated, 2011.
5. Norm Chapman, *"Principles of Electricity and electronics for the Automotive Technician"*, Delmar Cengage Learning, 2008.
6. Judge A.W, *"Modern Electrical Equipment of Automobiles"*, Chapman & Hall, London, 1992.

**Online Resources:**

1. https://b-ok.asia/book/526451/802478
2. https://b-ok.asia/book/2161298/3ad7b5

**Web Resources:**

1. https://www.youtube.com/watch?v=hs7bABMtOMI&list=PLyqSpQzTE6M9G2SNxKfsVEjcM9MlJau4F
2. https://www.youtube.com/watch?v=HHgPBMMZ26w

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4004 | RENEWABLE ENERGY CONVERSION SYSTEMS | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | RECS | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Nill

**Course Objectives:**

1. To create awareness about various Electric Energy Conversion Systems.
2. Learn the fundamental concepts about solar energy conversion systems and devices
3. To understand the solar thermal conversion systems for high temperature applications.
4. To learn Thermal and Bio-energy conversion systems
5. To Understand the various technologies that are used in WECS
6. To Understand the Fuel cell technology

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand various Electric Energy Conversion Systems (BTL-2) |
| **CO 2** | Analyze the solar thermal conversion system (Also for high temperature applications) (BTL-4) |
| **CO 3** | Analyze the Photovoltaic & Bio-Energy Conversion Systems (BTL-4) |
| **CO 4** | Illustrate the existing Wind Energy Conversion System (BTL-2) |
| **CO 5** | Extend the knowledge about working principle of various Fuel cell technology (BTL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 1 | 1 | | | | | | | | | | 1 | |
| CO2 | 2 | 2 | | | | | | | | | | | 1 | 2 |
| CO3 | 2 | 1 | | | | | | | | | | | 1 | 1 |
| CO4 | 2 | 1 | 1 | | | | | | | | | | | 2 |
| CO5 | 1 | 1 | 1 | | | | | | | | | | 1 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | ELECTRIC ENERGY CONVERSION SYSTEM | 12 Hrs |
|---|---|---|

Generation of electricity using different sources, Transmission and distribution losses, AC to DC and DC to AC conversions, Electric motors: Types, losses, efficiency, Lightning systems, Diesel generating systems.

At the end of the Module 1, students will be able to:

1. Understand various Electric Energy Conversion Systems.
2. Understand losses, efficiency related to Electric Energy Conversion Systems.

| MODULE -2 | SOLAR THERMAL CONVERSION SYSTEM | 12 Hrs |
|---|---|---|

Relevance of solar thermal power generation; Components of solar thermal power plant, Design and performance, characteristics of different solar concentrator types suitable for thermal power generation

| | | |
|---|---|---|
| **HIGH TEMPERATURE APPLICATIONS:** Types of solar thermal conversion system used in high temperature application, Tracking of solar concentrators; performance characterization of solar concentrators both line focus and point focus, Comparative analysis of the both mode focus system. | | |
| At the end of the Module 2, students will be able to:<br>1. Describe the existing solar Energy Conversion System<br>2. understand characteristics of different solar concentrators<br>3. Evaluate the solar thermal conversion systems for high temperature applications.<br>4. understand the working of various solar concentrators | | |
| **MODULE-3** | **THERMAL ENERGY CONVERSION & BIO-ENERGY CONVERSION SYSTEMS** | 8 Hrs |
| Thermo-electric generator, Concepts and design considerations of MHD generators, Cycle analysis of MHD systems, Thermionic power conversion and plasma diodes, Thermo chemical Conversion. Bio-energy conversion, bio methanation technology. | | |
| At the end of the Module 4, students will be able to:<br>1. Understand the Photovoltaic & Bio-Energy Conversion Systems<br>2. Analyze Thermo chemical and Bio-energy conversion | | |
| **MODULE-4** | **WIND ENERGY CONVERSION SYSTEM (WECS)** | 8 Hrs |
| Rotor Selection, Annual Energy Output, HAWT, VAWT, Rotor Design Considerations-Number of Blades, Blade Profile -2/3 Blades and Teetering, Coning- Upwind/Downwind, Power Regulation, Yaw System- Tower, Synchronous and Asynchronous Generators and Loads, Integration of Wind Energy Converters to Electrical Networks, Inverters. | | |
| At the end of the Module 5, students will be able to:<br>1. Describe the existing Wind Energy Conversion System.<br>2. understand the Rotor Design Considerations | | |
| **MODULE-5** | **FUEL CELL TECHNOLOGY** | 8 Hrs |
| Overview of fuel cells, Fuel cell thermodynamics, fuel cell efficiency, Fuel cell characterization, Fuel cell modelling and system integration, Balance of plant, Hydrogen production from renewable sources and storage, life cycle analysis of fuel cells | | |
| At the end of the Module 6, students will be able to:<br>1. Understand the Fuel cell technology<br>2. Understand the Fuel cell modelling and system integration | | |
| | **Total hours:** | **48 hours** |

**Term work:**

Individual assignment, followed by Quiz and End semester examinations

**Content beyond syllabus:**

Advance energy conversion process

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Electric Energy Conversion Systems | CO1 | https://www.britannica.com/technology/energy-conversio |

| | | | | |
|---|---|---|---|---|
| | 2 | solar energy conversion systems | CO2 | https://www.appropedia.org/Solar_energy_conversion_system https://www.sciencedirect.com/topics/engineering/thermal-solar-energy-system-technology |
| | 3 | Thermal and Bio-energy conversion systems | CO3 | http://www.fao.org/3/T1804E/t1804e06.htm |
| | 4 | Wind Energy Conversion Systems | CO4 | https://www.appropedia.org/Wind_energy_conversion_system |
| | 5 | Fuel cell technology | CO5 | https://www.hydrogenics.com/technology-resources/hydrogen-technology/fuel-cells/ |

**Text Book(s):**

1. S. S. L. Chang, Energy Conversion, Prentice Hall, 1963
2. R. J. Rosa, Magneto hydrodynamic Energy Conversion, Springer, 1987.
3. V. S. Bagotsky, Fuel Cell Problems and Solutions, John Wiley & Sons, 2009

**Reference Book(s):**

1. Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970
2. Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984

**Online Resources:**

1. https://archive.org/details/energyconversion00chan
2. https://www.trine.edu/books/documents/de_text1.0.0.pdf

**Web Resources:**

1. https://www.youtube.com/watch?v=mpHZWYpKDJg
2. https://www.youtube.com/watch?v=GExTwRNkQBg

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4009 | SOLAR AND FUEL CELL ENERGY SYSTEMS | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To make students understand the fundamental theory governing the photovoltaic devise and make them carry out preliminary system design.
2. To learn the fundamental knowledge about various fuel cell technologies.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the need of radiation of sun and discuss the various performance characteristics of solar radiation.(BL-2) |
| **CO 2** | Discuss the photovoltaic effect, PV Cell efficiency and its limits along with the concepts of fabrication technology for solar cell (BL-2) |
| **CO 3** | Predict the performance of solar photovoltaic device and analyze its performance. (BL-2) |
| **CO 4** | Carry out the application of photovoltaic system as power system. (BL-3) |
| **CO 5** | Analyze the performance of fuel cells under different operating conditions and also defend appropriate fuel cell technology for a given application. (BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 1 | | | 2 | 2 | | | | | | 2 | 1 |
| CO2 | 3 | 3 | 3 | | | 2 | 2 | | | | 2 | | 3 | 2 |
| CO3 | 2 | 2 | 1 | | | 2 | 2 | | | | 2 | | 2 | 2 |
| CO4 | 2 | 2 | | | | 2 | 2 | 2 | | | 2 | | 3 | 3 |
| CO5 | 2 | 3 | 2 | | | 2 | 2 | | | | 2 | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Solar Radiation | 08 Hours |
|---|---|---|

Sun as Energy Source, Solar Radiation at The Earth's Surface, Solar Radiation Geometry, Solar Time and Equation of Time, Sun Earth angles, Sun path diagram, Sunshine hours, Measurement of Solar Diffuse, Global and Direct Solar Radiation, Equipments, Estimation of Solar radiation on horizontal and tilted Surfaces, Global Solar radiation data, Indian Solar Radiation data analysis

At the end of the Module 1, students will be able to:

1.Understand the need of radiation of sun (BL-2)

2. Discuss the various performance characteristics of solar radiation.(BL-2)

| MODULE -2 | Solar Cells and its Fabrication | 07 Hours |
|---|---|---|

**Solar Cells**
Conversion of Solar energy into Electricity - Photovoltaic Effect, Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells, Recent developments in Solar Cells, Role of nano-technology in Solar cells
**Fabrication Technology for Solar Cells**
High efficiency multi-junction solar cell, Quantum well solar cell, Technology for the fabrication of thin film cells, Optical concentration, Effect of temperature on Cell performance, Thermo photovoltaic effect

At the end of the Module 2, students will be able to:

1. Discuss the photovoltaic effect, PV Cell efficiency and its limits (BL-2)
2. Discuss the concepts of fabrication technology for solar cell (BL-2)

| MODULE-3 | Solar Photovoltaic System | 10 Hours |
|---|---|---|

**Solar Photovoltaic System Design**
Solar cell array system analysis and performance prediction, Shadow analysis: Reliability, Solar cell array design concepts, PV system design, Design process and optimization: Detailed array design, Voltage regulation, Maximum tracking, Quick sizing method, Array protection.
**Solar Photo Voltaic System Testing**
Sun Simulator, Testing and performance assessment of Solar PV generator, Electronic Control and Regulation, Power Conditioning, Converters and inverter, Concentrating system, System design and configuration

At the end of the Module 3, students will be able to:

1. Predict the performance of solar photovoltaic device and analyze its performance. (BL-2)

| MODULE-4 | SPV Power Systems | 12 Hours |
|---|---|---|

Centralized and decentralized SPV systems, Stand alone, hybrid and, grid connected system, System installation, Operation and Maintenance, Application of PV for lighting, Water pumping. Refrigeration, Telecommunication, Cathodic Protection, Solar PV Power Plant-Status-Case Studies, Hybridization Engineering, Hybrid systems, Grid integration. Building Integrated PV Systems, PV market analysis and Economics of SPV systems.

At the end of the Module 4, students will be able to:

1. Carry out the application of photovoltaic system as power system. (BL-3)

| MODULE-5 | FUEL CELLS | 12 Hours |
|---|---|---|

History, Working principle of fuel cells, Fuel cell thermodynamics, fuel cell electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Volmer equation, performance evaluation of fuel cells, Types of Fuel Cells: AFC, PAFC, SOFC, MCFC, DMFC, relative merits and demerits.
**Fuel cell characterization** In-situ and ex-situ characterization techniques, I-V curve, frequency response analyses; Fuel cell system integration
**Application of Fuel Cells** Fuel Cell usage for domestic power systems, large scale power generation, Automobile, environmental analysis. Future trends in fuel cells, portable fuel cells, laptops, mobiles, submarines.

At the end of the Module 6, students will be able to:

1. Analyze the performance of fuel cells under different operating conditions. (BL-4)
2. Select and defend appropriate fuel cell technology for a given application. (BL-4)

| | |
|---|---|
| **Total hours:** | **48 hours** |

**Term work:**
1. Field trip

**Content beyond syllabus:**
1. Introduction of hydrogen energy systems
2. Hydrogen production processes
3. Hydrogen storage and safety

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | Indian Solar Radiation data analysis | https://www.nrel.gov/docs/fy21osti/78025.pdf |
| 2 | Role of nano-technology in Solar cells | https://www.intechopen.com/chapters/73145 |
| 3 | Converters and inverter in solar energy | https://www.energy.gov/eere/solar/solar-integration-inverters-and-grid-services-basics |
| 4 | Economics of SPV systems | https://extensionpublications.unl.edu/assets/pdf/g2182.pdf |
| 5 | Types of Fuel cells with relative merits and demerits | https://www.energy.gov/eere/fuelcells/types-fuel-cells |

**Text Book(s):**

1. Fundamentals of Solar Cells: PV Solar Energy Conversion by AL Fahrenbruch and RH Bube, Academic Press, New York.
2. Solar Photovoltaics. Fundamental Technologies and Application by Chetan Singh Solanki, PHI Publicaton.
3. Principles of Fuel Cells by Xianguo Li, Taylor & Francis.
4. Fuel cell Systems Explained by James Larminie and Andrew Dicks, John Wiley & Sons, Inc.
5. Fuel Cells: From Fundamentals to Applications by S Srinivasan, Springer.

**Reference Book(s):**

1. Principles of Solar Engineering by F Kreith and JF Kreider, McGraw-Hill.
2. Fuel Cell Fundamentals by O'Hayre, SW Cha, W Colella and FB Prinz, Wiley.
3. Fuel Cell Science and Technology by Basu, S. (Ed) Springer, N.Y.

**Online Resources:**

1. https://www.nrel.gov/docs/fy21osti/78025.pdf
2. https://www.intechopen.com/chapters/73145
3. https://www.energy.gov/eere/solar/solar-integration-inverters-and-grid-services-basics
4. https://extensionpublications.unl.edu/assets/pdf/g2182.pdf
5. https://www.energy.gov/eere/fuelcells/types-fuel-cells

**Web References:**

1. https://www.youtube.com/watch?v=--GfdbavEk8
2. https://www.youtube.com/watch?v=qFnAIxyPXuQ
3. https://www.youtube.com/watch?v=px239v5o6xU
4. https://www.youtube.com/watch?v=pH03Y5KwpjU
5. https://www.youtube.com/watch?v=6oeN9VDFLig

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4014 | WIND & BIOMASS ENERGY SYSTEM | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To acquire the knowledge on wind power generation
2. To Understand the concept of wind turbine design
3. To Discuss the Current trends in worldwide applications of wind power
4. To Understand the various methods Bio- Chemical Conversion systems
5. To Discuss the various applications of biomass

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the present wind energy scenario (BL-2) |
| **CO 2** | Explain the various wind energy technologies. (BL-3) |
| **CO 3** | Identify various applications of wind energy .(BL-2) |
| **CO 4** | Explain the various biomass conversion technologies and testing of performance of biogas. (BL-2) |
| **CO 5** | Understand the Bio-Energy Systems with Efficient Applications. (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO2 | 3 | 1 | 1 | 2 | | | | | | | | | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | | | | | | | | | 2 | 2 |
| CO4 | 2 | 2 | 3 | 2 | | | | | | | | | 3 | 3 |
| CO5 | 1 | 2 | 1 | | 2 | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Wind Power Generation | 08 Hours |
|---|---|---|

Introduction – Basic principles of wind energy conversion power in the wind-Forces on blades and thrust on turbines – Wind energy conversion – site selection Considerations -Basic components of WECS – Classification- Advantages and disadvantages – Power, torque and speed characteristics.

At the end of the Module 1, students will be able to:

1.Understand the need of wind energy (BL-2)

2. Explain the various performance characteristics of wind energy.(BL-1)

3. Understand the Basic principles of wind energy conversion system (BL-2)

| MODULE -2 | WECS design | 07 Hours |
|---|---|---|

Design of wind turbine :Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods.

Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss Correction.

At the end of the Module 2, students will be able to:

1. Discuss Wind turbine design considerations & characteristics (BL-2)
2. Discuss the concepts of Aerodynamic theories (BL-2)
3. Understand the concept of Maximum power coefficient (BL-2)

| MODULE-3 | Wind Energy Applications & Measurements | 10 Hours |
|---|---|---|

Wind energy measurements: Wind speed, Wind direction, Data measurement and analysis, Performance evaluation of Wind energy system, Wind potential assessment
Wind energy application Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy. Utilization; Wind energy in India; Case studies.

At the end of the Module 3, students will be able to:

1. Explain the various measuring instruments used in wind systems (BL-2)
2. Understand the wind energy applications(BL-2)
3. Understand the Current trends in worldwide applications of wind energy (BL-2)

| MODULE-4 | Biomass conversion Technologies | 12 Hours |
|---|---|---|

**Bio Energy:** Introduction – Biomass conversion technologies – Bio gas generation – Factors affecting bio digestion or generation of gas – Classification of bio gas plants – advantages and disadvantages –Materials used for biogas plant – selection of site for biogas plant
**Thermo-chemical conversions:** Direct Combustion, Technology of Biomass gasification, Pyrolysis and Liquefaction, Bio- Chemical Conversion: anaerobic digestion, alcohol production from biomass,
**Chemical conversion process:** hydrolysis and hydrogenation
**Biomass Gasifiers:** History, Principle, Design of Biomass Gasifiers, updraft gasifier, down draft gasifier, zero carbon biomass gasification plants, Gasification of plastic-rich waste, applications for cooking, electricity generation, Gasifier Engines, Operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol and biogas, Biomass integrated gasification/combined cycles systems.

At the end of the Module 4, students will be able to:

1. Discuss Biomass conversion technologies (BL-2)
2. Explain the concept of Bio- Chemical Conversion & Thermo-chemical conversions (BL-2)
3. Explain Direct & In-Direct Combustion methods (BL-2)
4. Discuss the historical perspective of biomass energy (BL-2)
5. Explain the Biomass Gasifiers (BL-2)
6. Discuss the concept of various Gasifier Engines (BL-2)

| MODULE-5 | Bio-Energy Systems with Efficient Applications | 12 Hours |
|---|---|---|

Traditional Stoves, Energy Efficient Cooking and Space heating Stoves, Metal Stoves Improved Gasifier Stoves, Pollution due to smoke emissions, Biogas Systems : Technology of Bio-gas production, Biogas Plants , Digester types, Digester design, Chemical kinetics and mathematical modeling of bio-methanation process, Dung, Vegetable Waste, Night Soil and Municipal Waste based Bio-gas plants, Bio gas as fuel for transportation, Lighting, Running Dual Fuel Engines, Electricity generation, Bio gas Bottling Plant Technology, Application of Bio gas slurry in agriculture , Design of Biogas for cold climates.

At the end of the Module 6, students will be able to:

1. Explain the Bio-Energy Systems with Efficient Applications (BL-2)
2. Identify various real time applications. (BL-3)
3. Discuss the various applications of bio- energy (BL-2)

| | |
|---|---|
| **Total hours:** | **48 hours** |

**Term work:**

1. Field trip

**Content beyond syllabus:**

1. Betz limit & Wind resource assessment

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | Basic components of WECS | https://www.youtube.com/watch?v=uUzqfckAlbg |
| 2 | Prandlt's tip loss Correction | https://www.youtube.com/watch?v=F9J2BdprXOQ |
| 3 | Wind energy measurements | https://www.youtube.com/watch?v=-N-QJkY1GEM |
| 4 | Biomass conversion technologies Design of Biomass Gasifiers | https://www.youtube.com/watch?v=H1hrkC--dto https://www.youtube.com/watch?v=RrBOqjCtkk0 |
| 5 | Night Soil and Municipal Waste based Bio-gas plants | https://www.youtube.com/watch?v=ehNEtJtaFR8 |

**Text Book(s):**

1. S.N.Bhadra,D.Kastha, S.Banerjee, " wind electrical systems" Oxford University Press
2. S.Rao & B.B.Parulekar, "Energy Technology", 4th edition, Khanna publishers, 2005.
3. "Energy conversion systems" by Rakosh das Begamudre, New age international publishers, New Delhi - 2000.

**Reference Book(s):**

1. "Renewable Energy sources & Conversion Technology" by N.K.Bansal, Manfred Kleemann, Michael Meliss. Tata Mcgraw Hill Publishers.
2. "The Electrical Energy Storage" by IEC Market Strategy Board.
3. Jim Eyer, Garth Corey, "Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report", Press, Feb 2010.

**Online Resources:**

1. https://www.lathamathavan.edu.in/lmgi/antiragging/WECS-%21EEE%20new.pdf
2.https://www.lathamathavan.edu.in/lmgi/antiragging/WECS-%21EEE%20new.pdf
3.https://engineering.purdue.edu/~dionysis/EE452/Lab9/Wind_Energy_Conversion.pdf
4. https://energystorage.org/why-energy-storage/technologies/
5. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118029008

**Web References:**

1. https://www.youtube.com/watch?v=mh51mAUexK4
2. https://www.youtube.com/watch?v=GExTwRNkQBg
3. https://www.youtube.com/watch?v=4a4XGu1mR5E
4. https://www.youtube.com/watch?v=xzY3CK43C98
5. https://www.youtube.com/watch?v=_OQtT4yhhWc

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4019 | UTILIZATION OF ELECTRICAL ENERGY | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | UCE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To Summarize various electric drives and traction motors with applications
2. To Understand the concepts of Mechanics of Train movement and associated calculations
3. To Explain the laws of illumination and their application for various lighting schemes
4. To understand the different methods of electric heating and electric welding
5. To identify how to utilize the solar radiation into electrical energy for different applications and to understand the basic principles of wind energy conversion

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Utilize the suitable electric drives for different applications(BL=3) |
| **CO 2** | Analyze the Speed-Time Curves of Different Services(BL=4) |
| **CO 3** | Identify the energy saving based on Illumination system (BL=3) |
| **CO 4** | Understand the utilization of electrical energy for heating and welding purposes(BL=2) |
| **CO 5** | Illustrate the effective usage of solar and wind energy for electrical applications(BL=2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | | | | | | | | | 1 | 3 |
| CO2 | 3 | 2 | | | | | | | | | | | | 3 |
| CO3 | 3 | 2 | | 2 | | | | | | | | | 2 | 2 |
| CO4 | 2 | | | 1 | 1 | | | | | | | | 1 | 2 |
| CO5 | 2 | 2 | 1 | | | | 2 | | | | | | 1 | 3 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | ELECTRIC DRIVES AND TRACTION | 12 Hrs |
|---|---|---|

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear

At the end of the Module 1, students will be able to:

1. Select the various Electric drives and Traction motors(BL=1)
2. Understand the types of railway electrification and track equipment(BL=2)
3. Explain the various electrical braking methods(BL=2)

| MODULE -2 | MECHANICS OF ELECTRIC TRACTION | 12 Hrs |
|---|---|---|

Mechanics of Train Movement. Speed-Time Curves of Different Services – Trapezoidal and Quadrilateral Speed-Time Curves – Numerical Problems. Calculations of Tractive Effort, Power, Specific Energy Consumption, Adhesive Weight and Coefficient of Adhesion.

<table>
<tr><td colspan="3">At the end of the Module 2, students will be able to:<br>1. Understand the Speed-Time Curves of Different Services(BL=2)<br>2. Explain the mechanics of train movement(BL=2)<br>3. Understand the factors effecting Specific Energy Consumption(BL=2)</td></tr>
<tr><td>MODULE-3</td><td>ILLUMINATION</td><td>08 Hrs</td></tr>
<tr><td colspan="3">Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapor lamps, fluorescent lamps –design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting – UPS- energy saving lamps, LED – working principle of air conditioning system</td></tr>
<tr><td colspan="3">At the end of the Module 3, students will be able to:<br>1. Explain the various light sources (BL=2)<br>2. Understand the various lighting schemes(BL=2)<br>3. Illustrate the Energy conservation through LED usage(BL=2)</td></tr>
<tr><td>MODULE-4</td><td>HEATING AND WELDING</td><td>08 Hrs</td></tr>
<tr><td colspan="3">Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating -resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types -resistance welding - arc welding - power supply for arc welding - radiation welding</td></tr>
<tr><td colspan="3">At the end of the Module 4, students will be able to:<br>1. Understand the various electrical heating methods(BL=2)<br>2. List the advantages of electric heating(BL=1)<br>3. Explain the electrical welding methods(BL=2)</td></tr>
<tr><td>MODULE-5</td><td>SOLAR & WIND ENERGY CONVERSION SYSTEM</td><td>08 Hrs</td></tr>
<tr><td colspan="3">Solar Energy Conversion System: Introduction - solar constant – terrestrial solar radiation - solar radiation geometry – estimation of average solar radiation - physical principles of the conversion of solar radiation into heat – flat-plate collectors - transmissivity of cover system - energy balance equation and collector efficiency -concentrating collector - advantages and disadvantages of concentrating collectors<br>Wind Energy Conversion System: Introduction - basic principles of wind energy conversion - site selection considerations - basic components of a WECS (Wind Energy Conversion System) - Classification of WECS - types of wind machines - analysis of aerodynamic forces acting on the blade</td></tr>
<tr><td colspan="3">At the end of the Module 5, students will be able to:<br>1. Understand the principles of the conversion of solar radiation into electrical energy(BL=2)<br>2. Explain the various solar energy collectors(BL=2)<br>3. Understand merits and demerits of concentrating collectors(BL=2)<br>4. Understand the principles of wind energy conversion(BL=2)<br>5. Illustrate the components of Wind Energy Conversion System(BL=2)<br>6. Understand the aerodynamic forces acting on the blade(BL=2)</td></tr>
<tr><td colspan="2">Total hours:</td><td>48 hours</td></tr>
</table>

**Term work:**

1.Report on different DC drives used in electric traction system in India
2.Report on different AC drives used in electric traction system in India
3.study different Electrification systems in traction and submit the report
4.Field trip to electric locomotive limited ,Tirupati and submit report on protection system used in electric locomotive
5. Field trip to electric locomotive limited ,Tirupati and submit report on energy consumption for different electric locomotives
6.Study the different lighting schemes & its line diagrams in Damodharam sanjeevaiah thermal power plant
7.Visit Nelcast industries,Gudur and submit the report on different types electric furnaces and its Rating
8. Visit Nelcast industries,Gudur and submit the report on protective schemes used for electric furnaces
9.Report on complete solar power utilization in India
10.Report on complete wind power utilization in India

**Content beyond syllabus:**

1. Energy Efficient Technologies in Electrical Systems

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | Reference |
|---|---|---|
| 1 | Electric Drives And Traction | https://www.electronicshub.org/electric-traction-system/ |
| 2 | Mechanics Of Electric Traction | https://www.engineeringenotes.com/electrical-engineering/electric-traction-electrical-engineering/train-movement-and-energy-consumption-electrical-engineering/37136 |
| 3 | Illumination | https://nptel.ac.in/courses/108/105/108105060/ |
| 4 | Heating And Welding | https://www.electrical4u.com/electric-heating/ **twi-global.com/technical-knowledge/faqs/what-is-arc-welding** |
| 5 | Solar & Wind Energy Conversion System | https://www.sciencedirect.com/topics/engineering/solar-collector https://www.awea.org/wind-101/basics-of-wind-energy https://www.slideshare.net/BansiKansagara/et-wind |

**Text Book(s):**

1. Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009.
2. N.V. Suryanarayana, “Utilisation of Electric Power”, Wiley Eastern Limited, New Age International Limited, 1993
3. J.B.Gupta, “Utilisation Electric power and Electric Traction”, S.K.Kataria and sons, 2000.
4. G.D.Rai,” Non-Conventional Energy sources”, Khanna publications Ltd.,New Delhi 1997
5. D.P.Kothari, K.C.Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learing Private Limited, 2013.

**Reference Book(s):**

1. Generation, distribution and utilization of electrical energy, C.L Wadhwa, Wiley Eastern Limited,1993
2. R.K.Rajput, Utilisation of Electric Power, Laxmi publications private Limited.,2007
3. H.Partab, Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co., New Delhi-2004.

**Online Resources:**

1. https://b-ok.asia/book/5441788/abf631
2. https://b-ok.asia/book/2871150/836618

**Web Resources:**

1.https://www.youtube.com/watch?v=fQrZMMWo1mA&list=PLbMVogVj5nJThs8VThC-DA8CZYsmaQypX&index=1
2. https://www.youtube.com/watch?v=5ZGh08q9K7E&list=PLEprwsbQ0B8ITTiaONpKN3Q-bEBJKTMlQ
3. https://www.youtube.com/watch?v=p3PkcLjNUhI
4.https://www.youtube.com/watch?v=TpvmJBeGUrg&list=PLyqSpQzTE6MKwjFQByBvRx464XpCgOEC&index=2
5. https://www.youtube.com/watch?v=GzMuLpsRY-8
6. https://www.youtube.com/watch?v=GExTwRNkQBg

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4024 | ENERGY AUDIT & DEMAND SIDE MANAGEMENT | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | EMS | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To learn about energy consumption and situation in India
2. To learn about Energy Management.
3. To learn about Energy Measuring Instruments.
4. To understand the Demand Side Management (DSM).
5. To understand the cost effectiveness for DSM.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Understand the importance of energy audit and the basic ideas of conduction an energy audit (BTL-2) |
| **CO 2** | Analyze various techniques of energy management and conservation (BTL-4) |
| **CO 3** | Understand energy efficient methods and power factor improvement techniques (BTL-2) |
| **CO 4** | Analyze demand side management concepts through case study (BTL-4) |
| **CO 5** | Understand various Cost effectiveness test for demand side management programs (BTL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 1 | | 1 | 2 | | 2 | | | 2 | 1 | | | 1 | 1 |
| CO2 | 1 | 2 | 1 | 1 | | 1 | 1 | | 2 | | 1 | | 2 | 1 |
| CO3 | | 1 | | 1 | | 1 | | | | | | | 2 | 1 |
| CO4 | 1 | 2 | | | | 1 | | | 1 | | | | 1 | 1 |
| CO5 | 1 | 1 | 2 | | | 1 | | | 1 | | | | 1 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Basic principles of Energy Audit | 12 Hrs |
|---|---|---|

Energy audit- definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes-Energy audit of industries-energy saving potential, energy audit of process industry, thermal power station, building energy audit

At the end of the Module 1, students will be able to:

1. Understand the concept of energy audit
2. Understand the various Energy conservation schemes

| MODULE -2 | Energy management | 12 Hrs |
|---|---|---|

**Energy management-I**

Principles of energy management, organizing energy management program, initiating, planning , controlling, promoting, monitoring, reporting.

**Energy management-II**

Energy manger, Qualities and functions , language ,Questionnaire - check list for top management

At the end of the Module 2, students will be able to:

1. Conduct energy management, energy audit and energy conservation measures.
2. Understand the basic principles of energy management
3. Understand the need of energy management
4. Evaluate energy audit results
5. Illustrate electrical load management techniques

| MODULE-3 | ENERGY MANAGEMENT FOR LIGHTING AND ENERGY MOTORS | 08 Hrs |
|---|---|---|

| | | |
|---|---|---|
| Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit<br>Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit | | |
| At the end of the Module 4, students will be able to:<br>1. understand the characteristics of energy efficient motors<br>2. Implement energy efficient methods and power factor improvement techniques | | |
| **MODULE-4** | **INTRODUCTION TO DEMAND SIDE MANAGEMENT** | 08 Hrs |
| Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs. | | |
| At the end of the Module 5, students will be able to:<br>1. Analyze demand side management concepts through case study<br>2. Understand the load management | | |
| **MODULE-5** | **ECONOMICS AND COST EFFECTIVENESS TESTS OF DSM PROGRAMS** | 08 Hrs |
| Basic payback calculations, Depreciation, Net present value calculations. Taxes and Tax Credit – Numerical Problems. Importance of evaluation, measurement and verification of demand side management programs. Cost effectiveness test for demand side management programs - Ratepayer Impact Measure Test, Total Resource Cost, Participant Cost Test, Program Administrator Cost Test | | |
| At the end of the Module 6, students will be able to:<br>1. Analyze economic impacts of energy management and auditing<br>2. Understand various Cost effectiveness test for demand side management programs | | |
| | **Total hours:** | **48 hours** |

**Term work:**

Term work contains assignments ,seminars and quiz

**Content beyond syllabus:**

1. Energy Instruments For Audit

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Energy Audit | CO1 | http://www.opexworks.com/KBase/Energy _Management/Energy_Audit_and _Management/Energy_Audit/Energy _Audit_Types_and_Methodology.htm |
| 2 | Overview of energy management | CO2 | https://beeindia.gov.in/sites/default/files/1Ch3.pdf<br><br>https://www.nrcan.gc.ca/sites/oee.nrcan.gc.ca /files/files/pdf/energy-audit-manual-and-tool.pdf |
| 3 | Energy management for motors | CO3 | https://www.youtube.com/watch?v=T9Vmp3Qo8Mo |
| 4 | Demand side management | CO4 | http://africa-toolkit.reeep.org/modules/Module14.pdf |

| | | | | |
|---|---|---|---|---|
| | 5 | Cost effective test of DSM | CO5 | https://www.youtube.com/watch?v=P4yfHQWYfLc |

**Text Book(s):**

**1.** Industrial Energy Management Systems**,** Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.

**2.** Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.

**Reference Book(s):**

1) Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2) Energy management by Paul o" Callaghan, Mc-graw Hill Book company-1/e,1998
3) Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2/e, 1995
4) Energy management hand book by W.C.Turner, john Wiley and sons
5). Energy management and good lighting practice: fuel efficiency- booklet12-EEO

**Online Resources:**

1. http://lab.fs.uni-lj.si/kes/erasmus/Energy%20Management%20Handbook.pdf
2. https://www.bsr.org/reports/bsr-energy-management-handbook.pdf

**Web Resources:**

1. https://freevideolectures.com/
2. https://www.academia.edu/33324894/Energy_Management_Handbook_7th_Ed_Doty_and_Turner_Fairmont_Press_2009--03-Oct-2009-.pdf?auto=download

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4005 | ADVANCED POWER ELECTRONICS | | | | | | | R2021 |
| | Hours / Week | | | Total | Credit | Max Marks | | |
| | L | T | P | hrs | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Power Electronics

**Course Objectives:**

1. To explain the concepts of power electronic switches
2. To demonstrate the applications and analysis of switches in DC-DC converter and various single phase converters
3. To analyze the operation of single phase, three phase and multipulse converters
4. To analyze the power quality improvement techniques
5. To analyze the allocations of FACTS devices

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Explain basic Concept of Switches and their controlling process (B-2) |
| **CO 2** | Demonstrate the device physics, Application and Analysis of Switches in DC-DC converters and Single Phase Converter (B-2) |
| **CO 3** | Analyze the operation Single Phase Converter, Three Phase Converter, Multipulse Converter and Effect of Source Inductance and PWM Rectifiers (B-4) |
| **CO 4** | Analyze the Power Quality Improvement Techniques in electrical systems (B-4) |
| **CO 5** | Analyze the applications of FACTS Devices in electrical system (B-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | | | | | | | | | | | 2 | 3 |
| CO2 | 3 | 2 | | | | | | | | | | | 2 | 3 |
| CO3 | 3 | 2 | | | | | | | | | | | 2 | 3 |
| CO4 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO5 | 3 | 2 | 2 | | | | | | | | | | 2 | 3 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Advanced Solid State Devices | 10 Hours |
|---|---|---|

MOSFETs, IGBT, GTO, IGCT etc. Power modules, intelligent power modules, gating circuits. Thermal design, protection. Digital signal processors used in their control.

At the end of the Module 1, students will be able to:

**1.** Recall the basic concepts of Switching characteristics **(BL-1)**

**2.** Understand the controlling techniques of switches **(BL-2)**

| MODULE -2 | DC – DC and Single Phase converters | 10 Hours |
|---|---|---|

Non-isolated dc-dc converters: Buck, boost, buck-boost, Cuk, SEPIC, Zeta in DCM and CCM. Isolated dc-dc converters: Flyback, forward, Cuk, SEPIC, Zeta, half bridge, push-pull and bridge in DCM and CCM. Single-phase, single-stage converters (SSSSC), power factor correction at ac mains in these converters. Their application in SMPS, UPS, welding and lighting systems.

| | | |
|---|---|---|
| At the end of the Module 2, students will be able to:<br>**1.** understand the concept of DC-DC conversion **(BL-2)**<br>**2.** explain the concept of single-pahse and single stage converters **(BL-2)** | | |
| **MODULE-3** | **AC-DC Converters** | **10 Hours** |
| Single-phase improved power quality ac-dc converters: Buck, boost, buck-boost, PWM VSC (Voltage source converters), multilevel VSCs, PWM CSC (Current voltage source converters). Three-phase improved power quality ac-dc converters: VSC, multilevel VSCs, multipulse VSCs, PWM CSC (Current voltage source converters). Multipulse ac-dc converters: Diode and thyristor based converters | | |
| At the end of the Module 3, students will be able to:<br>**1.** Understand the concept of power quality **(BL-2)**<br>**2.** Apply the various converters to improve the power quality **(BL-3)**<br>**3.** Analyze the various ac-dc converters **(BL-4)** | | |
| **MODULE-4** | **Passive and Active Filters** | **10 Hours** |
| Power quality mitigation devices: Passive filters, active filters, hybrid filters. DSTATCOM (Distribution static compensator), DVR (Dynamic voltage restorer) and UPQC (Universal power quality conditioner). | | |
| At the end of the Module 4, students will be able to:<br>**1.** Explain the concept of passive and active filters **(BL-2)**<br>**2.** Analyze different types of power quality mitigation devices **(BL-4)** | | |
| **MODULE-5** | **FACTS Devices** | **08 Hours** |
| FACTS devices: TCR (Thyristor Controlled Reactor), TSC (Thyristor Switched Capacitors). STATCOM (Static Synchronous Compensator). SSSC (Static Series Synchronous Compensator). UPFC (Unified Power Flow Controller), IPFC (Interline Power Flow Controller). | | |
| At the end of the Module 5, students will be able to:<br>**1.** Understand the concept of FACTS devices **(BL-2)**<br>**2.** Analyze the operation of different types of FACTS Devices **(BL-4)** | | |
| | **Total hours:** | **48 Hours** |

**Term work:**

**Content beyond syllabus:**

1. Advanced controlling techniques to improve Power Quality

**Self-Study:**

Contents to promote self-Learning:

| S.NO | Module | Reference |
|---|---|---|
| 1 | **Advanced Solid State Devices** | https://youtu.be/XgY3HiBhHEE |
| 2 | **DC – DC and Single Phase converters** | https://www.youtube.com/watch?v=p5NZw5fUvgQ |
| 3 | **AC-DC Converters** | https://www.youtube.com/watch?v=JXJaRPXPwjQ |
| 4 | **Passive and Active Filters** | https://www.youtube.com/watch?v=EoPGgrMAAJo |

| | | | | |
|---|---|---|---|---|
| | 5 | **FACTS Devices** | https://www.youtube.com/watch?v=GVxY3nE5mO8&list=PLLy_2iUCG87AVyRAN4QwVQrC8vSg1vWa6 | |

**Text Book(s):**

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2009.
3. Narain G. Hingorani, Laszlo Gyugyi, "Understanding FACTS", IEEE Press.

**Reference Book(s):**

1. Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996.
2. Muhammad H. Rashid , "Power Electronics Handbook", Elsevier, 3rd ed., 2011.
3. P.C.Sen, "Modern Power Electronics ", S. Chand and Co. Ltd., New Delhi, 2000.
4. Vijay K. Sood, "HVDC and FACTS Controllers Applications of Static Converters in Power Systems", Kluwer Academic Publishers, Boston, 2004.
5. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009

**Online Resources / Web References:**

1. https://www.youtube.com/watch?v=MeOYUx07SCk
2. https://www.youtube.com/watch?v=ErMz2MI5DQo
3. https://www.youtube.com/watch?v=ohwGWysVuXU
4. https://www.academia.edu/38805211/Advanced_Power_Electronics_Converters_PWM_Converters_Processing_AC_Voltages
5. https://www.electronicbo.com/2019/06/Advanced-Power-Electronics-Converters.html
6. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/
7. https://nptel.ac.in/courses/108/106/108106073/
8. https://www.youtube.com/watch?v=MeOYUx07SCk&list=PLUpFmz4G8ZyZx2fG5B_GRVIhTquypoAWZ
9. https://www.youtube.com/watch?v=ohwGWysVuXU
10. https://www.youtube.com/watch?v=0jevuayGmmU&list=PLLy_2iUCG87DzWK9cLYKxjH1LRACxdEKi

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4010 | ADVANCED ELECTRICAL DRIVES | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand steady state operation and transient dynamics of a motor load system.
2. To acquire knowledge of fuzzy logic and neural network concepts in various drives

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Analyze the Power electronic converters for electrical drives.(BL-4) |
| **CO 2** | Analyze the field oriented control of machines.(BL-4) |
| **CO 3** | Understand the vector control of electrical drives.(BL-2) |
| **CO 4** | Understand the sensor less control of AC drives.(BL-2) |
| **CO 5** | Analyze the direct torque control of Induction Machines.(BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 3 | | 2 | | | | | | | | 1 | 2 |
| CO2 | 2 | 2 | 3 | | 2 | | | | | | | | 1 | 2 |
| CO3 | 2 | 2 | 2 | | 2 | | | | | | | | 1 | 2 |
| CO4 | 2 | | 3 | | 2 | | | | | | | | | 2 |
| CO5 | 2 | 2 | 2 | | 2 | | | | | | | | | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1 (08 Hrs)**

**INTRODUCTION TO POWER CONVERTERS FOR ELECTRIC DRIVES**

Switching converters and their applications to variable frequency drives - Power electronic converters for control of amplitude-AC variable frequency drives - Mathematical representation of switching functions- reduction of switching losses in practical switches. MATLAB simulation -study on 'D0Q' transformation in various frames of reference. Free acceleration characteristics of Induction motor from 'D0Q' model viewed from various reference frames

At the end of the Module 1, students will be able to:

1. Explain the switching converters ad their application.(BL-2)
2. Understand the Power electronic converters for control of drives.(BL-2)
3. Explain the characteristics of Induction motor from various reference frames. (BL-2)

**MODULE -2 (10 Hrs)**

**FIELD ORIENTATED CONTROL**

Field oriented control of induction machines - Theory – DC drive analogy.

At the end of the Module 2, students will be able to:

1. Understand the field orientated control and its application. (BL-2)
2. Analyze the Field oriented control of induction machines. (BL-4)
3. Analyze the Field oriented control of DC drive. (BL-4)

**MODULE-3 (10 Hrs)**

**VECTOR CONTROL**

Vector control concept- Direct or Feedback vector control - Indirect or Feed forward vector control – Flux vector estimation - Space vector modulation control-PWM current control-MATLAB simulation direct & indirect vector control induction motor- closed loop speed control of VVVF PMAC motor drive & FPGA based closed loop control of BLDC motor drive.

At the end of the Module 3, students will be able to:

1. Understand the vector control concept. (BL-2)
2. Understand the MATLAB simulation direct & indirect vector of control induction motor. (BL-2).
3. Explain FPGA based closed loop control of BLDC motor drive. (BL-2)

**MODULE-4 (10 Hrs)**

**SENSORLESS CONTROL OF AC DRIVES**

Introduction to sensor less control of AC drives – Advantages – speed estimation methods-State synthesis method – model reference adaptive system – observer based techniques -MATLAB simulation model reference adaptive system for speed estimation.

At the end of the Module 4, students will be able to:

1. Understand the sensor less control of AC drives.(BL-2)
2. Explain the state synthesis method. (BL-2)
3. Understand the MATLAB simulation model reference adaptive system for speed estimation. (BL-2)

**MODULE-5 (10 Hrs)**

**DIRECT TORQUE CONTROL**

Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy – optimum switching vector selection – reduction of torque ripple methods- adaptive control. MATLAB simulation-open loop control-DTC of induction motor drive-adaptive control.

At the end of the Module 5, students will be able to:

1. Understand the Direct torque control of Induction Machines. (BL-2)
2. Explain the Torque expression with stator and rotor fluxes.(BL-2)
3. Explain optimum switching vector selection.(BL-2)

**Total hours: 48 hours**

**Content beyond syllabus:**

1. GA based drives

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Reduction of switching losses in practical | CO1 | https://www.youtube.com/watch?v=7kGPLVXvsPk |

| | | | |
|---|---|---|---|
| | switches | | |
| 2 | Field oriented control of induction machines | CO2 | https://www.youtube.com/watch?v=2jtk1_rcYYQ |
| 3 | FPGA based closed loop control of BLDC motor drive | CO3 | https://www.youtube.com/watch?v=V0XP3N5c2GY |
| 4 | MATLAB simulation model reference adaptive system for speed estimation | CO4 | https://www.youtube.com/watch?v=9W2CzT0wq3Q |
| 5 | DTC of induction motor drive | CO5 | https://www.youtube.com/watch?v=mG7AxRkGrr8 |

**Text Book(s):**

1. Bimal.K. Bose, "Power Electronics and Variable frequency drives", Standard Publishers Distributors, New Delhi, 2000.
2. Dubey G.K., "Power Semiconductor controlled drives", Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey, 1989.

**Reference Book(s):**

1. Murphy J.M.D, Turnbull, F.G, "Thyristor control of AC motor", Pergamon press, Oxford, 1988.
2. Sheperal, Wand Hully, L.N. "Power Electronic and Motor control" Cambridge University Press Cambridge, 1987.
3. Dewan, S. Slemon B., Straughen, A. G.R., "Power Semiconductor drives", John Wiley and Sons, NewYork, 1984.

**Online Resources:**

1. https://doku.pub/documents/electric-drives-by-gk-dubey-59qge6y3vm0n
2. https://nptel.ac.in/courses/108/104/108104011/

**Web Resources:**

1. https://www.youtube.com/watch?v=6DctdwlDKhc&list=PLA5CA7D35114BA425
2. https://www.youtube.com/watch?v=WsDPqDqnpyw&list=PLuv3GM6gsE3UGP1cSOl1KuEXscGFdKXB

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4015 | HVDC and FACTS | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | HVDC | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Transmission and Distribution, Power Electronics and High voltage engineering

**Course Objectives:**

1. To introduce the extra high voltage AC and DC transmission
2. To introduce the HVDC transmission system with types, control and protection.
3. To discuss about the design factors of lines and cables.
4. To provide knowledge on FACTS controllers.
5. To introduce the reactive power control techniques.
6. To study the characteristics, modelling and operating schemes of different types of shunt and series switched reactive power generating devices.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Find the applications of different types of HVDC links.(BL-2) |
| **CO 2** | Apply converters for HVDC transmission for control of converters.(BL-3) |
| **CO 3** | Understand the concept of filters to mitigate harmonics, concept of reactive power requirements.(BL-2) |
| **CO 4** | Understand the working principles of FACTS devices.(BL-2) |
| **CO 5** | Analyze the performance of Series, Shunt and combined FACTS controllers.(BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 2 | | | | | | | | | | 3 | 2 |
| CO2 | 3 | | 3 | | | | | | | | | | 2 | 2 |
| CO3 | 2 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO4 | 2 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO5 | 2 | 2 | 3 | | | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Introduction | 10Hrs |
|---|---|---|

Comparison of AC and DC transmission systems, application of DC transmission, types of DC links, typical layout of a HVDC converter station, HVDC converts, pulse number, analysis of Gratez circuit with and without overlap, converter bridge characteristics, equivalent circuits or rectifier and inverter configurations of twelve pulse converters.

At the end of the Module 1, students will be able to:

1. Explain the comparison of HVDC and HV AC.(BL-2)
2. Understand the Application of the HVDC Transmission.(BL-2)
3. Understand the Characteristics of 6 pulse and 12 pulse converters.(BL-2)

| MODULE -2 | CONVERTER & HVDC SYSTEM CONTROL | 10Hrs |
|---|---|---|

Principle of DC link control –Converters control characteristics- system control hierarchy, firing angle control, current and excitation angle control, starting and stopping of DC link.

| | | |
|---|---|---|
| At the end of the Module 2, students will be able to:<br>1. Understand the principle of DC link control.(BL-2)<br>2. Understand the Firing Angle Control for the Converters.(BL-2)<br>3. Explain the starting and stopping of DC link. (BL-2) | | |
| **MODULE-3** | **HARMONICS, FILTERS AND REACTIVE POWER CONTROL** | **10Hrs** |
| Introduction, generation of Harmonics, AC and DC Filters. Reactive power requirements in steady state, sources of reactive power, static VAR systems.<br>**POWER FLOW ANALYSIS IN AC/DC SYSTEMS:** Modeling of DC/AC converts, controller equations solutions of AC/DC load flow- simultaneous method, sequential method. | | |
| At the end of the Module 3, students will be able to:<br>1. Understand the Basics generation of harmonics.(BL-2)<br>2. Explain the calculation of voltage & Current harmonics. (BL-2)<br>3. Explain the types of AC filters.(BL-2) | | |
| **MODULE-4** | **INTRODUCTION TO FACTS** | **10Hrs** |
| Flow of power in AC parallel paths and meshed systems, basic types of FACTS controllers, brief description and definitions of FACTS controllers.<br>**STATIC SHUNT COMPENSATION**: Objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators, SVC and STATCOM, comparison between SVC and STATCOM. | | |
| At the end of the Module 4, students will be able to:<br>1. Explain the basic principles, characteristics of different types of FACTS controllers. (BL-2)<br>2. Explain the new methods adopted in power system control. (BL-2)<br>3. Understand the static shunt compensation. (BL-2) | | |
| **MODULE-5** | **STATIC SERIES COMPENSATORS** | **8Hrs** |
| Objectives of series compensation, variable impedance type- thyristor switched series capacitors (TCSC), and switching converter type series compensators, static series synchronous compensator (SSSC)- power angle characteristics-basic operating control schemes. | | |
| At the end of the Module 5, students will be able to:<br>1. Understand the objectives of series compensation of power systems. (BL-2)<br>2. Understand the power angle characteristics. (BL-2)<br>3. Explain the basic operating control schemes. (BL-2) | | |
| | **Total hours:** | **48 hours** |

**Term work:**

1. Develop HVDC Transmission system using mat lab software
2. The steady-state and transient performance of a 12-pulse, 1000 MW (500 kV-2kA) 50/60 Hz HVDC transmission system.
3. FACTS and HVDC Technologies for the Development and Enhancement of Future Power Systems.
4. Use of HVDC and FACTS which can be applied in transmission and distribution systems
5. Simulation of various applications using FACTs devices.
6. AC-DC Power flow analysis using FACTS devices.
7. Stabilty of Power Transmission Capability of HVDC system using facts controllers.
8. Design of DC breakers modelling using MATLAB
9. Design of Power control in HVDC using MATLAB
10. Modelling and digital simulation of STATACOM using MATLAB

**Content beyond syllabus:**

1. Design of real-time industrial projects.
2. Application of various compensation techniques in power system.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | Reference |
|---|---|---|
| 1 | Introduction of DC power transmission | https://www.cet.edu.in/noticefiles/229_HVDC_NOTE.pdf |
| 2 | Analysis of HVDC converters | https://aits-tpt.edu.in/wp-content/uploads/2018/08/HVDC-2-Unit.pdf |
| 3 | Control of HVDC converter and systems | https://sari-energy.org/oldsite/PageFiles/What_We_Do/activities/HVDC_Training/Presentations/Day_2/3.HVDC_CONTROLS.pdf |
| 4 | Introduction To Facts | https://nptel.ac.in/courses/108/107/108107114/ |
| 5 | Static Series Compensators | https://nptel.ac.in/courses/108/107/108107114/ |

**Text Book(s):**

1. Padiyar, K. R., "HVDC power transmission system", New Age International (P) Ltd., New Delhi, Second Edition, 2010.
2. Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Wiley interscience, New York, London, Sydney, 1971.
3. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", New Age International (P) Ltd., New Delhi, 1990.
4. R.MohanMathur,RajivK.Varma,"Thyristor–Based Facts Controllers for Electrical Transmission Systems", IEEE press andJohnWiley&Sons,Inc,2002.
5.Narain G.Hingorani, "Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors,Delhi-110006,2011.

**Reference Book(s):**

1. Direct Current Transmission, Vol. 1, E. W. Kimbark, Wiley, 1971
2. High Voltage Direct Current Transmission, Jos Arrillaga, IEE Power and Energy series 29, 2nd Edition, 1998
3. EHV-AC, HVDC Transmission & Distribution Engineering, S Rao, Khanna Publishers, 4 th Edition, 2008.
4.K.R.Padiyar,"FACTS Controllersin Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008
5. A.T.John,"FlexibleA.C.TransmissionSystems",InstitutionofElectricalandElectronic Engineers(IEEE), 1999.
6. V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004,KluwerAcademic Publishers,2004.

**Online Resources/ Web Resources:**

1. https://nptel.ac.in/courses/108/104/108104013/
2. http://www.ee.uidaho.edu/ee/power/ee
3. https://www.powereng.com/our-services/power-delivery/hvdc-fact/
4. https://en.wikipedia.org/wiki/High-voltage_direct_current
5. https://www.ti.com/lit/an/sloa289a/sloa289a.pdf?ts=1592377419880&ref_url=https%253A%252F%2www.google.co.in%252F
7. https://pv-magazine-usa.com/2020/03/31/hvdc-transmission-helps-investors-but-may-not-help-solar/
8. http://www.renewableenergyfocus.com/view/3567/hvdc-transmission-from-energy-source-to-consumer/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21EE4020 | ADVANCED POWER CONVERTERS | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Power Electronics

**Course Objectives:**

1. To analyze the dc-dc voltage regulators
2. To describe the operation of resonant converters
3. To describe the operation of multi level converters and multi pulse converters with switching strategies for high power
4. To understand Principle of Operation DC power supplies
5. To analyze the AC power supplies

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Evaluate different dc-dc voltage regulators**(BL-3)** |
| **CO 2** | Analyze resonant converters**(BL-3)** |
| **CO 3** | Evaluate various multi-level inverter configurations **(BL-3)** |
| **CO 4** | Select appropriate phase shifting converter for a multi-pulse converter**(BL-3)** |
| **CO 5** | Analyze the various DC power supplies **(BL-3)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | | | | | | | | | | | 2 | 3 |
| CO2 | 3 | 2 | 2 | | | | | | | | | | 3 | 3 |
| CO3 | 1 | 1 | 1 | | | | | | | | | | 2 | 3 |
| CO4 | 2 | 2 | | | | | | | | | | | 2 | 2 |
| CO5 | 1 | 3 | | | | | | | | | | | 2 | 3 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Switching Voltage Regulators | 10**Hours** |
|---|---|---|

Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations like Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter; Design criteria for SMPS; Multi-output switch mode regulator.

At the end of the Module 1, students will be able to:

1. Recall the basic concepts of voltage regulators **(BL-1)**
2. Understand the other converter configurations **(BL-2)**
3. Evaluate the different dc voltage regulators**(BL-3)**

| MODULE -2 | Resonant Converters | 10 Hours |
|---|---|---|

Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zerovoltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies.

At the end of the Module 2, students will be able to:

1. understand the concept of resonant conversion**(BL-2)**
2. compare & analyzethe zero voltage and current switching dc-dc converters**(BL-2)**

| MODULE-3 | Multi-level converters | 10 Hours |
|---|---|---|

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations applications, Introduction to carrier based PWM technique for multi-level converters.

At the end of the Module 3, students will be able to:

1. Understand the concept of multi-level **(BL-2)**
2. Evaluate various multi-level inverter configurations **(BL-3)**
3. Understandcarrier based PWM technique for multi-level converters**(BL-2)**

| MODULE-4 | Multipulse Converters | 08 Hours |
|---|---|---|

Concept of multi-pulse, Configurations for m-pulse (m=12,18,24 ….) converters, Different phase shifting transformer (Y-Δ1, Y-Δ2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications.

At the end of the Module 4, students will be able to:

1. Explain the concept of multi-pulse**(BL-3)**
2. Analyze different phase shifting transformer configurations for multi-pulse converters**(BL-4)**
3. Understand the applications of multipulse converters**(BL-2)**

| MODULE-5 | DC & AC Power Supplies | 10 Hours |
|---|---|---|

DC Power Supplies – Types – Switched Mode DC Power Supplies – Fly Back Converter –Forward Converter – Push-Pull Converter – Half Bridge Converter – Full Bridge Converter –Resonant DC Power Supplies – Bidirectional Power Supplies – Applications –AC Power Supplies – Types – Switched Mode Ac Power Supplies – Resonant AC Power Supplies – Bidirectional Ac Power Supplies – Multistage Conversions – Control Circuits – Power Line Disturbances – Power Conditioners – Uninterruptible Power Supplies – Applications

At the end of the Module 5, students will be able to:

1. Understand the switched mode dc power supplies**(BL-2)**
2. Analyze the types of dc power supplies **(BL-3)**
3. Analyze Bidirectional Power Supplies (BL-3)

| **Total hours:** | **48 Hours** |
|---|---|

**Term work:**

1. Evaluate the performance and operating modes of SLR/PLR dc-dc converter with the change in switching frequency.
2. Simulate/Design a circuit for a Buck Converter with ZVS/ZCS to regulate the output voltage Vo with a given input voltage Vin.
3. Carrier based Sine PWM control of a CHB multilevel inverter and study of harmonic spectrum.
4. Study the operation and performance of second order converters like Buck-Boost, Fly back, forward converters etc.
5. Study the operation and performance of fourth order converters like C'uk or Sepic converters
6. Study of harmonic spectrum for 12 and 18 pulse converters.
7. Design based Problems (DP)/Open Ended Problem: Course coordinator can assign the design based problem/open ended problem.
8. Major Equipment: Simulation software like MATLAB, PSIM, Scilab, Power Electronic Converters, CRO/DSO, meters, Current/Voltage Probes, Isolation transformer etc. as demanded by the course.

**Content beyond syllabus:**

1.Advanced multilevel converters

**Self-Study:**

Contents to promote self-Learning:

| S.NO | Module | Reference |
|---|---|---|
| 1 | **Switching Voltage Regulators** | https://www.youtube.com/watch?v=Q0E-ZAsqzKE |
| 2 | **Resonant Converters** | https://www.youtube.com/watch?v=53avTO3BYnI |
| 3 | **Multi-level converters** | https://www.youtube.com/watch?v=J3iEhAtcwZs |
| 4 | **Multipulse Converters** | https://www.youtube.com/watch?v=cqT6oOh3ggc |
| 5 | **DC Power Supplies** | https://www.youtube.com/watch?v=flAETm0RreY |
| 6 | **AC Power Supplies** | https://www.youtube.com/watch?v=DwiBp-Oohvs |

**Text Book(s):**

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2009.
3. Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.

**Reference Book(s):**

1. Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996.
2. Muhammad H. Rashid , "Power Electronics Handbook", Elsevier, 3rd ed., 2011.
3. P.C.Sen, "Modern Power Electronics ", S. Chand and Co. Ltd., New Delhi, 2000.
4. Vijay K. Sood, "HVDC and FACTS Controllers Applications of Static Converters in Power Systems", Kluwer Academic Publishers, Boston, 2004.
5. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009

**Online Resources / Web References:**

1. https://www.youtube.com/watch?v=MeOYUx07SCk
2. https://www.youtube.com/watch?v=ErMz2MI5DQo
3. https://www.youtube.com/watch?v=ohwGWysVuXU
4. https://www.academia.edu/38805211/Advanced_Power_Electronics_Converters_PWM_Converters_Processing_AC_Voltages
5. https://www.electronicbo.com/2019/06/Advanced-Power-Electronics-Converters.html
6. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/
7. https://nptel.ac.in/courses/108/106/108106073/
8. https://www.youtube.com/watch?v=MeOYUx07SCk&list=PLUpFmz4G8ZyZx2fG5B_GRVIhTquypoAWZ
9. https://www.youtube.com/watch?v=ohwGWysVuXU
10. https://www.youtube.com/watch?v=0jevuayGmmU&list=PLLy_2iUCG87DzWK9cLYKxjH1LRACxdEKi

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21EE4025 | ADVANCED POWER SEMICONDUCTOR DEVICES AND PROTECTION | | | | | | | R2021 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 48 | 3 | 40 | 60 | 100 |

**Pre-requisite:** Review of introductory concepts of power semiconductor devices

**Course Objectives:**

**OBJECTIVES:**

1. To improve power semiconductor device structures for adjustable speed motor controlapplications.
2. To understand the static and dynamic characteristics of current controlled powersemiconductor devices
3. To understand the static and dynamic characteristics of voltage controlled powersemiconductor devices
4. To enable the students for the selection of devices for different power electronicsApplications
5. To understand the control and firing circuit for different devices.

**Course Outcomes**: After successful completion of the course, the student will be able to:

| | |
|---|---|
| **CO 1** | Analyze power switching devices **(BL-4)** |
| **CO 2** | Design of current controlled devices and their parameters**(BL-3)** |
| **CO 3** | Analyze the voltage controlled devices and their parameters **(BL-2)** |
| **CO 4** | Understand new power semiconductor devices**(BL-2)** |
| **CO 5** | Design of protecting circuit**(BL-3)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | | | | | | | | | | | 2 | 2 |
| CO2 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO3 | 3 | 2 | | | | | | | | | | | 2 | 2 |
| CO4 | 3 | 2 | | | | | | | | | | | 2 | 2 |
| CO5 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |

1: Low, 2-Medium, 3- High

| COURSE CONTENT | | |
|---|---|---|
| **MODULE – 1** | **POWER SWITCHING DEVICES** | 10**Hours** |

Power switching devices overview – Attributes of an ideal switch, application requirements,circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state andswitching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

At the end of the Module 1, students will be able to:

1. Understand the Power switching devices overview**(BL-2)**
2. Analyze the Device selection strategy **(BL-3)**
3. Analyze the Power diodes **(BL-3)**

| MODULE -2 | CURRENT CONTROLLED DEVICES | 10 Hours |
|---|---|---|
| BJT's – Construction, static characteristics, switching characteristics; Negative temperaturecoefficient and second breakdown; - Thyristors – Physical and electrical principle underlyingoperating mode, Two transistor analogy – concept of latching; Gate and switchingcharacteristics; converter grade and inverter grade and other types; series and paralleloperation; comparison of BJT and Thyristor – steady state and dynamic models of BJT Thyristors- Basics of GTO, MCT, FCT, RCT | | |
| At the end of the Module 2, students will be able to:<br>**1.** Analyze the switching characteristicsofBJT**(BL-3)**<br>**2.** Analyze the Two transistor analogy**(BL-3)**<br>**3.** Understand the basics of thyristors**(BL-3)** | | |
| **MODULE-3** | **VOLTAGE CONTROLLED DEVICES** | **10 Hours** |
| Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types,static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs -and IGCT | | |
| At the end of the Module 3, students will be able to:<br>**1.** Understand the principle of voltage controlled devices**(BL-2)**<br>**2.** Analyze the switching characteristics of MOSFET & IGBT**(BL-3)** | | |
| **MODULE-4** | **NEW SEMICONDUCTOR MATERIALS FOR DEVICES** | **10 Hours** |
| New semiconductor materials for devices – Intelligent power modules- Integratedgate commutated thyristor (IGCT) - Comparison of all power devices. | | |
| At the end of the Module 4, students will be able to:<br>**1.** Understand the Intelligent power modules**(BL-2)**<br>**2.** Analyze the Integratedgate commutated thyristor**(BL-3)**<br>**3.** Compare all power devices**(BL-2)** | | |
| **MODULE-5** | **FIRING AND PROTECTING CIRCUITS** | **08 Hours** |
| Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET,IGBTs and base driving for power BJT. - Over voltage, over current and gate protections;Design of snubbers.Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling | | |
| At the end of the Module 5, students will be able to:<br>**1.** Understand the necessity of isolation**(BL-2)**<br>**2.** Analyze the Gate drives circuit**(BL-3)**<br>**3.** Understand the design of snubbers**(BL-2)** | | |
| **Total hours:** | | **48 hours** |

**Term work:**

1. Study of design of SiC MOSFETs
2. Tabulate the details of SCRs of different ratings
3. Derivation and explanation of transient thermal impedance of SCR
4. Study of thermal design of SCR with derivations
5. Study and explain paper on the state of the art and future trends of power semiconductors

**Content beyond syllabus:**

Protection against external & internal over voltages.

**Self-Study:**

Contents to promote self-Learning:

| S.NO | Module | Reference |
|---|---|---|
| 1 | Power Switching Devices | https://www.youtube.com/watch?v=7XsuRUXF4wE |
| 2 | Current Controlled Devices | https://www.youtube.com/watch?v=5Jf_WWt-5vg |
| 3 | Voltage Controlled Devices | https://www.youtube.com/watch?v=lzwqcMvuYxU |
| 4 | New Semiconductor Materials For Devices | https://www.youtube.com/watch?v=88lo7MgCpNo |
| 5 | Firing And Protecting Circuits | https://www.youtube.com/watch?v=XyuY8OgMQL4 |

**Text Book(s):**


1. B.W Williams 'Power Electronics Circuit Devices and Applications'..
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
3. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
4. Mohan, Undeland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.
5. Joseph Vithayathil, Power Electronics: Principles and Applications, Delhi, Tata McGraw-Hill, 2010.


**Reference Book(s):**


1. Advanced power electronics converters by Euzeli dos santos, Edison R. da silva.
2. Fundamentals of Power Semiconductor Devices by B. JayanthBaliga, Springer Press, 2008.
3. Power Semiconductor Devices and Circuits, Jaecklin, **A.A.**
4. Fundamentals of Power Semiconductor Devices, **Baliga**, B. Jayant


**Online Resources/ Web References:**

1. https://www.amazon.in/Power-Electronics-Drives-Advanced-Applications-ebook/dp/B086H4Z9WY
2. https://www.pdfdrive.com/25-advanced-power-semiconductor-devices-apsd-e456994.html
3. https://www.ttiinc.com/content/ttiinc/en/resources/product-types/discretes.html?utm=1267&channel=ppc&gclid=CjwKCAjw1K75BRAEEiwAd41h1AEeMfdQ65z0DUsEWQSBV_cFEI5VwuQnFLxopFizjnXDYRY4iPtUoRoCkAEQAvD_BwE
4. http://site.iugaza.edu.ps/malramlawi/files/RASHID_Power_Electronics_Handbook.pdf
5. https://www.youtube.com/watch?v=h0Y9jDKqScQ&list=PLgMDNELGJ1CaNcuuQv9xN07ZWkXE-wCGP
6. https://www.youtube.com/watch?v=m-uY4fja_Jw&list=PLOzRYVm0a65dVYOA7_3-N67Xu1NIrLnR0
7. https://www.youtube.com/watch?v=-YgHdIqkbs0
8. https://www.youtube.com/watch?v=5-uQ4rLlWPE

# List of Open Elective Subjects

| S.No | BoS Subjects from department of EEE | Sem/Branch | Category |
|---|---|---|---|
| **Open Elective Subjects** | | | |
| 1. | Artificial Neural Networks and Fuzzy Logic | NA | OE |
| 2. | Basic Electrical and Electronic Engineering | NA | OE |
| 3. | Energy Auditing and Demand Side Management | NA | OE |
| 4. | Electrical Measurements and Instrumentation | NA | OE |
| 5. | Utilization of Electrical Energy | NA | OE |
| 6. | Industrial Automation Engineering | NA | OE |
| 7. | Industrial Electrical Systems | NA | OE |
| 8. | Renewable Energy Conversion Systems | NA | OE |
| 9. | Power Quality | NA | OE |

# *1. ARTIFICIAL NEURAL NETWORKS & FUZZY LOGIC*

**MODULE – 1 INTRODUCTION TO ARTIFICIAL INTELLIGENCE 10 hrs**

Introduction to Artificial intelligence, Approaches to AI, Architectures of AI, Symbolic reasoning system, Rule based systems, Knowledge representation, Expert systems.

**MODULE -2 ARTIFICIAL NEURAL NETWORKS 10 hrs**

Basics of ANN, Comparison between Artificial and Biological Neural Networks, Basic Building Blocksof ANN, Artificial Neural Network Terminologies, McCulloch Pitts Neuron Model, Learning Rules, ADALINE and MADALINE Models, Perceptron Networks, Back Propagation Neural Networks – Associative Memories.

**MODULE-3 ANN APPLICATIONS TO ELECTRICAL SYSTEMS 8 hrs**

ANN approach to: Electrical Load Forecasting Problem, System Identification, Control Systems, Pattern Recognition.

**MODULE-4 CLASSICAL RELATIONS AND FUZZY RELATIONS 10 hrs**

Classical Sets, Fuzzy Sets, Operations on classical sets, Properties of crisp sets, Operations on fuzzy sets, Properties of Fuzzy sets, Fuzzy Relations- Cardinality, Cartesian product, Fuzzy compositions, Fuzzy Equivalence Relation & Fuzzy Tolerance Relation

**MODULE-5 FUZZY LOGIC AND APPLICATION 10 hrs**

Fuzzification & Defuzzification- Methods, Membership Functions, Fuzzy Rule base, Genetic Algorithm , Fuzzy Logic Controller Design, Features of a simple Fuzzy Logic Control system, NeuroFuzzy Controller. Fuzzy Logic Implementation for Induction Motor Control, Switched Reluctance Motor Control, Fuzzy Excitation Control Systems in Automatic Voltage Regulator, Fuzzy Logic Controller in an 18 Bus Bar System. **Total : 48 hrs**

**Text Book(s):**


1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Neural Networks using MATLAB",McGraw Hill Edition, 2006.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Third Edition,WILEY India Edition,2012.
3. Neural Networks – Simon Hakins , Pearson Education


**Reference Book(s):**


1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Fuzzy Logic using MATLAB", Springer International Edition, 2013.
2. Yung C. Shin and Chengying Xu, "Intelligent System – Modeling, Optimization & Control, CRC Press, 200
3. Elaine Rich, Kevin Knight ,Shivashankar B Nair, " Artificial intelligence" McGraw Hill third Edition

## 2. BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

**MODULE – 1** **DC & AC Circuits** **08 hrs**

Electrical circuit elements (R - L and C) - Kirchhoff laws - Series and parallel connection of resistances with DC excitation. Superposition Theorem - Representation of sinusoidal waveforms - peak and rms values - phasor representation - real power - reactive power – apparent power.

**MODULE -2** **DC Machines** **08 hrs**

Principle and operation of DC Generator - EMF equations - principle and operation of DC Motor –Types of DC Motor - Brake Test on DC Shunt Motor - Characteristics of DC Motor - Applications.

**MODULE-3** **AC MACHINES** **08 hrs**

Principle and operation of Single Phase Transformer - OC and SC test on transformer - principle and operation of Three Phase Induction Motor - Characteristics and Applications.

**PART B:**

**MODULE-4** **Semicondcutor Diodes** **08 hrs**

PN diode, Diode as Switch, Zener Diode, Tunnel diode, Varactor diode, LED, Photodiode: their characteristics and applications

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**MODULE-5** **Bipolar Junction Transistor** **08 hrs**

Bipolar Junction Transistor (BJT) – Types of Transistors, Operation of NPN and PNP Transistors, Input- Output Characteristics of BJT-CB, CE and CC Configurations, Relation between IC, IB and IE, Transistor Applications- Transistor as an Amplifier, Transistor as a Switch.

**MODULE-6 Metal–Oxide–Semiconductor Field-Effect Transistor** **08 hrs**

Introduction to MOSFET, Construction of depletion mode and enhancement mode of NMOS and PMOS, Drain characteristics of MOSFET, Transfer Characteristics of MOSFET, MOSFET as Switch, CMOS Inverter and it's Characteristics. **Total : 48 hrs**

**Text Book(s):**


1.D. P. Kothari and I. J. Nagrath - “Basic Electrical Engineering” - Tata McGraw Hill - 2010.

2.Basic Electrical and Electronics Engineering, M.S.Sukhija, T.K.Nagsarkar, Oxford University.

3.V.K. Mehta &Rohit Mehta, “Principles of Electronics” – S.Chand –2018.

4. Basic Electrical and Electronics Engineering, S.K Bhattacharya, Pearson Education,2012.


**Reference Book(s):**


1. L. S. Bobrow - “Fundamentals of Electrical Engineering” - Oxford University Press - 2011.

2 J. Millman, C. Halkias, “Electronic Devices and Circuits”, Tata Mc-Graw Hill, 4th Edition,2010.

3.David A.Bell, “Electronic Devices and Circuits”, Fifth Edition, Oxford University Press, 2009.

## 3.ENERGY AUDITING AND DEMAND SIDE MANAGEMENT

**MODULE – 1 INTRODUCTION TO ENERGY AUDITING 10 hrs**

Energy Situation – World and India, Energy Consumption, Conservation, Energy audit- definitions, concept, types of audit, energy index, cost index ,pie charts, Sankey diagrams , load profiles, Energy conservation schemes- Energy audit of industries

**MODULE -2 ENERGY MANAGEMENT 9 hrs**

Principles of energy management, organizing energy management program, initiating, planning , Controlling, promoting, monitoring, reporting. Energy manger, Qualities and functions ,language ,Questionnaire - check list for top management.

**MODULE-3 ENERGY EFFICIENT MOTORS AND POWER FACTOR IMPROVEMENT 10 hrs**

Energy Efficient Motors , Factors Affecting Efficiency, Loss Distribution , Constructional Details , Characteristics - Variable Speed , Variable Duty Cycle Systems, RMS Hp- Voltage Variation-Voltage Unbalance- Over Motoring- Motor Energy Audit. Power Factor – Methods of Improvement, Power factor With Non Linear Loads.

**MODULE-4 LIGHTING AND ENERGY INSTRUMENTS FOR AUDIT 9 hrs**

Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit - Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tong Testers, Application of PLC's.

**MODULE-5 CONCEPTS,ECONOMIC ASPECTS AND COSTEFFECTIVENESS TESTS OF DSM PROGRAMS 10 hrs**

Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Techniques, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Basic payback calculations, Depreciation, Net present value calculations, Cost effectiveness test for demand side management programs. **Total : 48 hrs**

### *Text Book(s):*


1. Industrial Energy Management Systems**,** Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.
2. Fundamentals of Energy Engineering -Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey 1984.
3. Handbook on Energy Audit and Environment Management ,YPAbbi and Shashank Jain,TERI, 2006


### *Reference Book(s):*


1. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o" Callaghan, Mc-graw Hill Book company-1/e,1998
3. Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2/e, 1995
4. Energy management hand book by W.C.Turner, john Wiley and sons
5. Energy management and good lighting practice: fuel efficiency- booklet12-EEO
6. Economic Analysis of Demand Side Programs and Projects - California Standard Practice Manual, June 2002 – Free download available online

## *4.ELECTRICAL MEASUREME AND INSTRUMENTATION*

**MODULE – 1** **Measurement of voltage & current** **10 hrs**

General principles of measurements –essentials of indicating instruments - deflecting, damping, controlling torques-Ammeters and voltmeters - moving coil, moving iron, constructional details, operation, Expression for deflecting & controlling torques and errors compensations- principles shunts and multipliers – extension of range.

**MODULE -2** **Measurement of Power, Energy, Power factor** **10 hrs**

**Power meters**: Dynamometer type wattmeter –1-phase and 3-phase - LPF and UPF- Double Element and Three Element wattmeter's.
**Energy meters**: Single Phase Induction Type Energy Meter – Driving and Braking Torques – Errors and Compensations. Three Phase Energy Meter-TOD meter
**P.F. Meters**: Dynamometer and Moving Iron Type – 1-ph and 3-ph Meters.

**MODULE-3** **Measurement of Resistance, Inductance and Capacitance** **9 hrs**

**Measurement of Resistance**: Kelvin's double bridge -Whetstone's bridge, sensitivity, limitations- loss of charge method -Megger method.
**Measurement of Inductance and Capacitance**: Maxwell's inductance and capacitance bridge-Hay's bridge- Anderson's bridge- Desauty's bridge -Schering bridge-weins bridge- Problems

**MODULE-4** **Extension of Instrument Ranges** **9 hrs**

**Instrument transformers**: Current Transformers and Potential Transformers – Ratio and Phase Angle Errors – Methods for Reduction of Errors-Design Considerations.
**Potentiometers:** Principle and Operation of D.C. Crompton‟s Potentiometer – Standardization – Measurement of unknown Resistance, Current, Voltage -AC Potentiometers: Polar and Coordinate types-Standardization – Applications.

**MODULE-5** **Transducers** **10 hrs**

Definition and classification - common transducers for measurement of displacement, velocity, flow, liquid level, force, pressure, strain and temperature -LVDT, electromagnetic and ultrasonic flow meters, piezoelectric force transducer, load cell, strain gauge- bridge configuration for four strain gauges, RTD, Thermistors, thermocouple, data acquisition system. **Total : 48 hrs**

**Text Book(s):**

1. Electrical & Electronic Measurements and Instrumentation by AK Sawhney, Dhanpat Rai & Sons Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.-2017
2. J. B. Gupta - A course in Electronic and Electrical measurements and Instrumentation, S. K. Kataria Publication-2020
3.Electrical Measurements & Measuring Instruments by M.L.Anand (Author)-2014

**Reference Book(s):**

1 Electrical Measurements and Measuring Instruments (English, Paperback, F. C. Widdis, E. W. Golding) January 2011
2. Electrical & Electronic Measurement & Instrumentation by R. K. Rajput, 2nd Edition, S. Chand & Co., 2nd Edition, 2013.

# 5. UTILIZATION OF ELECTRICAL ENERGY

**MODULE – 1 Electric Drives and Traction 10 hrs**

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear

**MODULE -2 Mechanics of Electric Traction 10 hrs**

Mechanics of Train Movement. Speed-Time Curves of Different Services – Trapezoidal and Quadrilateral Speed-Time Curves – Numerical Problems. Calculations of Tractive Effort, Power, Specific Energy Consumption, Adhesive Weight and Coefficient of Adhesion.

**MODULE-3 Illumination 10 hrs**

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapor lamps, fluorescent lamps –design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting – UPS-energy saving lamps, LED – working principle of air conditioning system.

**MODULE-4 Heating And Welding 8 hrs**

Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating -resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types -resistance welding - arc welding - power supply for arc welding - radiation welding.

**MODULE-5 Solar & Wind Energy Conversion System 10 hrs**

**Solar Energy Conversion System:** Introduction - solar constant – terrestrial solar radiation - solar radiation geometry – estimation of average solar radiation - physical principles of the conversion of solar radiation into heat – flat-plate collectors - transmissivity of cover system - energy balance equation and collector efficiency - concentrating collector - advantages and disadvantages of concentrating collectors.

**Wind Energy Conversion System:** Introduction - basic principles of wind energy conversion - site selection considerations - basic components of a WECS (Wind Energy Conversion System) - Classification of WECS - types of wind machines - analysis of aerodynamic forces acting on the blade

**Total : 48 hrs**

**Text Book(s):**

1. Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009.
2. N.V. Suryanarayana, “Utilisation of Electric Power”, Wiley Eastern Limited, New Age International Limited, 1993
3. J.B.Gupta, “Utilisation Electric power and Electric Traction”, S.K.Kataria and sons, 2000.

**Reference Book(s):**

1. Generation, distribution and utilization of electrical energy, C.L Wadhwa, Wiley Eastern Limited,1993
2. R.K.Rajput, Utilisation of Electric Power, Laxmi publications private Limited.,2007
3. H.Partab, Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Co., New Delhi-2004.
4. G.D.Rai,” Non-Conventional Energy sources”, Khanna publications Ltd.,New Delhi 1997

# 6. INDUSTRIAL AUTOMATION ENGINEERING

**MODULE – 1 FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION** **10 hrs**

Definition of automation- Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Types of production and types of automation, automation strategies,levels of automation, Industrial bus systems: modbus & profibus

**MODULE -2 AUTOMATION COMPONENTS** **9 hrs**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**MODULE-3 PROGRAMMABLE LOGIC CONTROLLERS** **10 hrs**

Introduction — Principles of operation – PLC Architecture and specifications – PLC hardware components Analog & digital I/O modules, CPU & memory module – Programming devices – PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram. PLC programming Simple instructions – Manually operated switches – Mechanically operated a Proximity switches - Latching relays.

**MODULE-4 APPLICATIONS OF PROGRAMMABLE LOGIC CONTROLLERS** **9 hrs**

Timer instructions - On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine, Bottle label detection and process control application.

**MODULE-5 DISTRIBUTION AUTOMATION & SCADA** **10 hrs**

**DISTRIBUTION AUTOMATION:** Distribution Automation (DA)-Benefits- Communication Technologies- Automatic Meter Reading(AMR)- Geographical Information System (GIS)- Consumer Information Service (CIS), Internet of things (IoT) for plant automation

**SCADA:** Introduction, Block Diagram, Components of SCADA, Functions of SCADA,SCADA applied to DA-Communication protocols in SCADA systems. **Total : 48 hrs**

## *Text Book(s):*


1. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies,2nd Edition 2003
2. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning, 3rd Edition,2005.
3. Bolton , "Programmable Logic Controllers" 5th Edition Newnes, ,2009
4. Electric Power Distribution Automation, Dr. M. K. Khedkar and Dr. G. M. Dhole, University Science Press, 2010.
5. Electric Power Distribution, A.S. Pabla, Tata Mc Graw Hill (India) Pvt. Ltd., 6th Edition, 2011.


**Reference Book(s):**


1. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
2. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000
3. Electric Power Distribution Engineering, Turan Gonen, CRC Press, 3rd Edition,2014.
4. Electrical Power Systems for Industrial Plants, Kamalesh Das, JAICO Publishing House, 2008.
5. Electrical Power Distribution Systems, V. Kamaraju, Jain Book Depot. 2012.

# 7.INDUSTRIAL ELECTRICAL SYSTEMS

**MODULE – 1** **Electrical System Components** **10 hrs**

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

**MODULE -2** **Residential and Commercial Electrical Systems** **10 hrs**

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection Devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

**MODULE-3** **Illumination Systems** **9 hrs**

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

**MODULE-4** **Industrial Electrical Systems** **10 hrs**

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction. Introduction to PCC, MCC panels. DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

**MODULE-5** **Industrial Electrical System Automation** **9 hrs**

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation. **Total : 48 hrs**

**Text Book(s):**

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.

**Reference Book(s):**

1.S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.. Web site for IS Standards.
2.. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

## *8. RENEWABLE ENERGY CONVERSION SYSTEMS*

**MODULE – 1 ENERGY CONSERVATION 10 hrs**

Over view of conventional & renewable energy sources, need & development of renewable energy sources, types of renewable energy systems, Energy scenario — global and national; Renewable energy potential, Energy for sustainable development, Global climate change, concept of Hybrid systems.

**MODULE -2 SOLAR & WIND ENERGY SOURCES 10 hrs**

**SOLAR ENERGY SOURCE**: solar radiation, Measurements of Solar Radiation, Collectors, working principle of photo voltaic cell, Equivalent Circuit model, Performance Characteristics, Applications.

**WIND ENERGY SOURCE:** Introduction, site selection considerations for installing wind mill, Construction details of the wind mill (Wind Turbine Gear System), Types of Wind Power Plants.

**MODULE-3 THERMAL ENERGY & BIO-MASS 10 hrs**

**THERMAL ENERGY:** Thermo-electric generator, Concepts and design considerations of MHD generators, Cycle analysis of MHD systems

**BIO-MASS**: Biomass resources and their classification, Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

**MODULE-4 GEOTHERMAL ENERGY & OCEAN ENERGY 9 hrs**

**GEOTHERMAL ENERGY:** Principle of geothermal energy, Resources, types of wells, methods of harnessing the energy, Economic Aspects, scope in India.

**OCEAN ENERGY**: Ocean Thermal Energy Conversion (OTEC), Principle of operation, development of OTEC plants, Tidal and wave energy.

**MODULE-5 FUEL CELL ENERGY 9 hrs**

Description, properties and operation of fuel cells, Major components & general characteristics offuel cells, Indirect methanol fuel cell systems. Phosphoric acid fuel cell systems and molten carbonate fuel cell systems, applications. **Total : 48 hrs**

**Text Book(s):**


1. Non conventional Energy sources, G.D. Rai, Khanna Publishers.
2. Renewable energy resources: Tiwari and ghosal, Narosa publication.
3. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill
4. D.P.Kothari,Rakesh Ranjan and K.C.Singal,Renewable Energy Resources & Emerging Tech prentice Hall of India Pvt.Ltd
5. Non conventional energy resources "Prentice Hall Inc,India by Sawhney G.S


## *Reference Book(s):*


1. Renewable Energy Sources: Twidell & Weir, CRC Press.
2. Solar Energy/ S.P. Sukhatme, Tata McGraw-Hill.
3. Non Conventional Energy Systems: K M. Mittal, A H WheelerPublishing Co Ltd.
4. Renewable Energy Technologies: Ramesh & Kumar, Narosa publication. 5. Biomass Energy, Oxford & IBH Publication Co.

# 9. POWER QUALITY

**MODULE – 1** **Introduction** 10 hrs

Definition of Power Quality- Power Quality Terminology – Classification of Power Quality Issues-Magnitude Versus Duration Plot - Power Quality Standards - Responsibilities of Suppliers and Users of Electric Power-CBEMA and ITI Curves.

**MODULE -2** **Transients, Short Duration and Long Duration Variations** 10 hrs

Categories and Characteristics of Electromagnetic Phenomena in Power Systems- Impulsive and Oscillatory Transients-Interruption - Sag-Swell-Sustained Interruption - Under Voltage – Over Voltage–Outage. Sources of Different Power Quality
Disturbances- Principles of Regulating the Voltage- Conventional Devices for Voltage Regulation.

**MODULE-3** **Fundamentals Of Harmonics & Applied Harmonics** 10 hrs

Harmonic Distortion, Voltage Versus Current Distortion, Harmonics Versus Transients, Power System Quality Under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads. Applied Harmonics**:** Effects Of Harmonics, Harmonic Distortion Evaluations, Principles of Controlling Harmonics, Devices for Controlling Harmonic Distortion.

**MODULE-4** **Power Quality Monitoring** 10 hrs

Power Quality Benchmarking-Monitoring Considerations- Choosing Monitoring Locations-Permanent Power Quality Monitoring Equipment-Historical Perspective of Power Quality Measuring Instruments- Power Quality Measurement Equipment-Types of Instruments-Assessment of Power Quality Measurement Data- Power Quality Monitoring Standards.

**MODULE-5** **Power Quality Enhancement Using Custom Power Devices** 8 hrs

Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL)-Solid State Breaker (SSB) –Solid State Transfer Switch (SSTS) – Compensating Type: Dynamic Voltage Restorer (DVR)-Unified Power Quality Conditioner(UPQC)-Principle of Operation Only.

**Total : 48 hrs**

**Text Book(s):**

1. Electrical Power Systems Quality, Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H.Wayne Beaty, Mc Graw Hill Education (India) Pvt. Ltd., 3rd Edition, 2012.
2. Power quality, C. Sankaran, CRC Press, 2001.
3. J.Arillaga, N.R.Watson and S.Chen, “Power System Harmonics”, John Wiley and Sons, England, 2005

**Reference Book(s):**

1. Understanding Power quality problems – Voltage Sags and Interruptions, Math H. J. Bollen IEEE Press Series on Power Engineering, WILEY, 2007.
2. Power quality – VAR Compensation in Power Systems, R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2009, First Indian Reprint 2013.
3. Fundamentals of Electric Power Quality, Surya Santoso, Create Space, 2012.

# ***LIST OF HONOR SUBJECTS***

| S.NO | Course code | Course Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | 21EEH001 | Adaptive Control Systems | 3-1-0 | 4 |
| 2 | 21EEH002 | AC Drives | 3-1-0 | 4 |
| 3 | 21EEH003 | Advanced Power System Protection | 3-1-0 | 4 |
| 4 | 21EEH004 | Power System Wide area Monitoring and Control | 3-1-0 | 4 |
| 5 | 21EEH005 | Restructed Power Systems | 3-1-0 | 4 |

# 1. ADAPTIVE CONTROL SYSTEMS

**MODULE – 1**Introduction, Block Diagram of an Adaptive System, Effects of Process Variations on System Performance, Types of Adaptive Schemes, Formulation of the Adaptive Control Problem, Abuses of Adaptive Control, Least Squares Method and Regression Models for Parameter Estimation – Theorems, Estimating Parameters in Models of Dynamic Systems, The Finite Impulse Response Model, The Transfer Function Model, and The Stochastic Model

**MODULE – II**

Block Diagram of Deterministic Self Tuning Regulator (STR), Pole Placement Design – Process Model, Model Following, Causality Conditions. Indirect STRs – Estimation, Continuous - Time STRs, Direct STRs – Minimum Phase Systems, Adaptive Control Algorithm, Feed Forward Control, Non Minimum Phase Systems – Adaptive Control Algorithm, Algorithm For Hybrid STR.

**MODULE – III**

Design of Minimum Variance and Moving - Average Controllers, Stochastic STR – Indirect STR, Algorithm for Basic STR, Theorems on Asymptotic Properties. Unification of Direct STRs, Generalized Direct Self Tuning Algorithm, Self Tuning Feed Forward Control. Linear Quadratic STR – Theorems on LQG Control, Algorithms for Indirect LQG – STRs Based on Spectral Factorization and Riccati Equation.

**MODULE –IV**

Model Reference Adaptive System (MRAS), The MIT Rule, Block Diagram of an MRAS for adjustment of Feed Forward Gain based on MIT Rule. Adaptation Gain – Methods for determination. Design of MRAS using Lyapunov Theory – Block Diagram of an MRAS basedon Lyapunov Theory for a First Order System. Proof of The Kalman – Yakubovich Lemma, Adjustment Rules for Adaptive Systems, Relation between MRAS and STR.

**MODULE – V**

Gain Scheduling – Principle, Block Diagram, Design of Gain Scheduling Controllers, Nonlinear Transformations, Block Schematic of a Controller based on Nonlinear Transformations. Application of Gain Scheduling for Ship Steering, Flight Control. Self Oscillating Adaptive System (SOAS) – Principle, Block Diagram, Properties of The Basic SOAS, Procedure for Design of SOAS. Industrial Adaptive Controllers and applications.

**Text books**

1. K.J.Astrom and Bjorn Wittenmark, Adaptive control, Pearson Edu., 2nd Edn.Sastry, Adaptive control

**References**

1. V.V.Chalam, Adaptive Control System - Techniques & Applications, Marcel Dekker Inc.
2. Miskhin and Braun, Adaptive control systems, MC Graw Hill
3. Karl Johan Åström, Graham Clifford Goodwin, P. R. Kumar, Adaptive Control, Filteringand Signal Processing
4. G.C. Goodwin, Adaptive control.

## 2. AC DRIVES

**MODULE** -I Phase Controlled Induction Motor Drive Stator Voltage Control of Induction Motor, Phase-Controlled Converter Fed Induction Motor, Power Circuit and Gating, Reversible Phase-Controlled Induction Motor Drive, Torque-Speed Characteristics.

**MODULE** -II: Voltage Source Inverter Fed Induction Motor Drive Stator Voltage and Frequency Control of Induction Motor, Torque-Speed Characteristic Static Frequency Changers, PWM Inverter Fed Induction Motor Drive, Variable-Voltage Variable- Frequency Operation of Induction Motor, Constant E/f And V/f Control Schemes, Slip Regulation.

**MODULE** -III: Rotor Side Control of Slip-Ring Induction Motor Slip-Power Recovery Schemes, Steady-State Analysis- Range of Slip, Equivalent Circuit, Performance Characteristics; Rating of Converters.
Vector Control of Induction Motor:
Principles of Vector Control, Direct Vector Control, Indirect Vector Control, Implementation
– Block Diagram, Estimation of Flux, Flux Weakening Operation.

**MODULE** -IV: Control of Synchronous Motor Drives Synchronous Motor - Control Strategies-Constant Torque Angle Control-Power Factor Control, Constant Flux Control, Flux Weakening Operation, Load Commutated Inverter Fed Synchronous Motor Drive, Motoring and Regeneration, Phasor Diagrams.

**MODULE** -V: PMSM and BLDC Drives Characteristics of Permanent Magnet, Synchronous Machines With Permanent Magnet, Vector Control of PMSM- Motor Model and Control Scheme, Constant Torque Angle Control, Constant Mutual Flux Linkages, Unity PF Control. Modelling of PM Brushless DC Motor, Drive Scheme, Commutation Torque Ripple, Phase Advancing.

**TEXT BOOK:**


1. R. Krishnan, **Electric Motor Drives Modelling, Analysis & control**, PearsonEducation, 2001.
2. B. K. Bose **Modern Power Electronics and AC Drives**, Pearson Publications, 2001.


**REFERENCE BOOKS:**


1. MD Murphy & FG Turn Bull, Power Electronics control of AC motors, 1st Edition,Pergaman press, 1998.
2. G.K. Dubey, **Fundamentals of Electrical Drives,** Narosa Publications, 1995.
3. S. K. Pillai, A First Course on Electrical Drives, New Age International, 1989.
4. Vedam Subrahmanyam, Electric Drives: Concepts and Applications, 2nd Edition, McGraw Hill Education, 2017

## 3. ADVANCED POWER SYSTEM PROTECTION

**MODULE** -I: Static Relays:

Advantages of static relays – Basic construction of static relays – Level detectors – Replica impedance – Mixing circuits – General equation for two input phase and amplitude comparators -Duality between amplitude and phase comparators. Amplitude Comparators: Circulating current type and opposed voltage type – rectifier bridge comparators, Direct and Instantaneous comparators.

**MODULE** -II: Phase Comparators:

Coincidence circuit type – block spike phase comparator, techniques to measure the period of coincidence – Integrating type – Rectifier and Vector product type – Phase comparators. Static Over Current Relays: Instantaneous over-current relay – Time over-current relays-basic principles – definite time and Inverse definite time over-current relays.

**MODULE**: Static Differential Relays:

Analysis of Static Differential Relays – Static Relay schemes – Duo bias transformer differential protection – Harmonic restraint relay. Static Distance Relays: Static impedance-reactance – MHO and angle impedance relay-sampling comparator – realization of reactance and MHO relay using sampling comparator.

**MODULE** -IV: Multi-Input Comparators:

Conic section characteristics -Three input amplitude comparator – comparator-switched distance schemes – Poly phase distance schemes – phase fault scheme – three phase scheme – combined and ground fault scheme. Power Swings: Effect of power swings on the performance of distance relays – Power swing analysis – Principle of out of step tripping and blocking relays – effect of line and length and source impedance on distance relays.

**MODULE** -V: Microprocessor Based Protective Relays:

Block diagram and flowchart approach only – Over current relays – impedance relays – directional relay – reactance relay – Generalized mathematical expressions for distance relays -measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of offset MHO characteristics – Basic principle of Digital computer relaying.

TEXT BOOK:


- Badri Ram and D. N. Vishwakarma, “Power system protection and Switch gear “, TMH publication New Delhi 1995.


REFERENCES:


- T.S. Madhava Rao , “Static relays”, TMH publication, second edition, 1989.
- Protection and Switchgear, Bhavesh Bhalja, R. P. Maheshwari, Nilesh G. Chothani, Oxford University Press.
- Electrical Power System Protection, C. Christopoulos and A. Wright, Springer International.

## 4. POWER SYSTEM WIDE AREA MONITORING AND CONTROL

**MODULE - I : COMPUTER CONTROL OF POWER SYSTEMS**

Need for real - time and computer control of power systems, operating states of a power system - 3 state & 5 states operation of power system - Supervisory Control and Data Acquisition system (SCADA), implementation considerations, energy control centers. WAMS (Wide Area Measurement system): Architecture, Components of WAMS, GUI (Graphical User Interface), Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, WAMPAC (Wide Area Monitoring Protection & Control), RAS (Remedial Action Scheme). Standards: IEEE 1344, IEEE C37.118 (2005), IEEE Standard C37.111-1999 (COMTRADE), IEC61850 GOOSE.

**MODULE - II : STATE ESTIMATION IN POWER SYSTEMS**

Introduction, Power system state estimation, Maximum likelihood, Weighted least Square estimation, Weighted least square estimation. State Estimation of AC Networks: Types of measurements, Linear weighted least square (WLS) estimation theory, DC Load flow based WLS state estimation, Linearised model of WLS state estimation of Non - Linear AC power systems, sequential and non - Sequential methods to process measurements, Typical results of state estimation on an Ac network.

**MODULE - III : TYPES OF STATE ESTIMATION AND NETWORK OBSERVABILITY**

State estimation by conventional WLS (normal equations), Orthogonal decomposition and its algorithm, hybrid method. Tracking of state estimation, Dynamic state estimation, Detection and identification of bad measurements, estimation of quantities not being measured. Network observability and pseudo-measurements, observability by graphical technique and triangularisation approach, Optimal meter placement, Application of power system state estimation.

**MODULE - IV : POWER SYSTEM SECURITY ANALYSIS**

Concept of security, Security analysis and monitoring, factors affecting power system security, detection of network problems, an overview of security analysis. Contingency analysis for generator and line outages by Interactive Linear Power Flow (ILPF) method, Fast decoupled inverse Lemma based approach, network sensitivity factors, Contingency selection, concentric relaxation and bounding.

**MODULE – V: VOLTAGE STABILITY**

Basic concepts, Voltage collapse – general characterization, clasiffication, Voltage stability analysis – modeling, dynamic analysis, static analysis, shortest distance to instability, continuation power flow analysis, prevention of voltage collapse – design measures, operating measures.

**TEXT BOOKS:**


1Allen J. Wood and Bruce Woolenberg, Power System Generation, Operation and Control, John Wiley and Sons, 1996.

2.John J. Grainger and William D Stevenson Jr, Power System Analysis, McGraw Hill ISE, 1994.


**REFERENCE BOOKS:**


1.E. Handschin, Real-time Control of Electrical Power Systems, Elsevier Publications & Co, 1988.

2.Special Issue on Computer Control of Power Systems, IEEE Proc, July 1974.

3.P. Kundur, Power System Stability and Control, McGraw Hill.

4.Fahd Hashiesh, M. M. Mansour , Hossam E. Mostafa Fahd Hashiesh , M. M. Mansour , Hossam E. Mostafa, Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids, Lambert Academic Publishing.

## 5. RESTRUCTURED POWER SYSTEMS

### MODULE I: KEY ISSUES IN ELECTRIC UTILITIES

Introduction – Restructuring models – Independent System Operator (ISO) – Power Exchange
- Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion.

### MODULE II: OPEN ACCESS SAME-TIME INFORMATION SYSTEM (OASIS) & MARKETPOWER

Structure of OASIS - Posting of Information – Transfer capability on OASIS. Market Power: Introduction - Different types of market Power – Mitigation of Market Power - Examples.

### MODULE III: AVAILABLE TRANSFER CAPABILITY (ATC) & ELECTRICITY PRICING

Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow. Electricity Pricing: Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

### MODULE IV: POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT

Introduction – Operational Planning Activities of ISO- The ISO in Pool Markets – The ISO in Bilateral Markets – Operational Planning Activities of a GENCO.

### MODULE V: TRANSMISSION COST ALLOCATION METHODS & ANCILLARY SERVICES MANAGEMENT

Introduction - Transmission Cost Allocation Methods : Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods. Ancillary Services Management: Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

### TEXT BOOKS :


1. Kankar Bhattacharya, Math H.J. Boller and Jaap E.Daalder, Operation of RestructuredPower System, Kulwer Academic Publishers, 2001.
2. Mohammad Shahidehpour and Muwaffaq alomoush, Restructured Electrical Power Systems, Marcel Dekker, Inc., 2001.


### REFERENCE BOOKS:


1. Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd., England.

# LIST OF MINOR SUBJECTS

| S.NO. | Course code | Course Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | 21EEM001 | Electrical Technology | 3-1-0 | 4 |
| 2 | 21EEM002 | Electrical Measurements and Instrumentation | 3-1-0 | 4 |
| 3 | 21EEM003 | Power System Architecture | 3-1-0 | 4 |
| 4 | 21EEM004 | Utilization of Electrical Energy | 3-1-0 | 4 |
| 5 | 21EEM005 | Linear Control Systems | 3-1-0 | 4 |

## 1. ELECTRICAL TECHNOLOGY

**MODULE – 1 DC GENERATORS**

D.C. Generators– Principle of Operation– Constructional Features– E. M.F Equation–Numerical Problems– Methods of Excitation– Separately Excited and Self Excited Generators– Build-Up of E.M.F, OCC.

**MODULE -2 D.C MOTORS**

D.C Motors– Principle of Operation– Back E.M.F.–Torque Equation–Types of DC motors, Characteristicsand Application of Shunt, Series and Compound Motors-Speed Control of D.C. Motors: Armature Voltage and Field Flux Control Methods. Three Point Starter-Losses–Swinburne's Test.

**MODULE-3 SINGLE PHASE TRANSFORMERS**

Single Phase Transformers- Constructional Details- Emf Equation- Operation on No Load and on Load - Phasor Diagrams -Equivalent Circuit- Losses and Efficiency-Regulation-OC and SC Tests - Predeterminationof Efficiency and Regulation.

**MODULE-4 POLYPHASE INDUCTION MOTORS**

Polyphase Induction Motors-Construction Details of Cage and Wound Rotor Machines Principle of Operation– Slip- Rotor Emf and Rotor Frequency- Torque Equation- Torque-Slip Characteristics.

**MODULE-5 SYNCHRONOUS MACHINES**

Synchronous Machines-Principle And Constructional Features of Salient Pole and Round Rotor Machines– E.M.F Equation- Voltage Regulation by Synchronous Impedance Method- Theory of Operation of Synchronous Motor.

**Total hours: 48 hours**

**Text Book(s):**

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Basic Electrical Engineering –By T.K.Nagasarkar and M.S. Sukhija Oxford University Press.
3. Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2010, 16th Reprint 2015.

**Reference Book(s):**

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw HillEducation, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

## *2. ELECTRICAL MEASUREMENTS AND INSTRUMENTATION*

**MODULE – 1 Measurement of voltage & current**

General principles of measurements –essentials of indicating instruments - deflecting, damping, controlling torques-Ammeters and voltmeters - moving coil, moving iron, constructional details, operation, Expression for deflecting & controlling torques and errors compensations- principles shunts and multipliers – extension of range.

**MODULE -2 Measurement of Power, Energy, Power factor**

**Power meters**: Dynamometer type wattmeter –1-phase and 3-phase - LPF and UPF- Double Element and Three Element wattmeter's.
**Energy meters**: Single Phase Induction Type Energy Meter – Driving and Braking Torques – Errors and Compensations. Three Phase Energy Meter-TOD meter
**P.F. Meters**: Dynamometer and Moving Iron Type – 1-ph and 3-ph Meters.

**MODULE-3 Measurement of Resistance, Inductance and Capacitance**

**Measurement of Resistance**: Kelvin's double bridge -Whetstone's bridge, sensitivity, limitations- loss of charge method -Megger method.
**Measurement of Inductance and Capacitance**: Maxwell's inductance and capacitance bridge-Hay's bridge- Anderson's bridge- Desauty's bridge -Schering bridge-weins bridge- Problems

**MODULE-4 Extension of Instrument Ranges**

**Instrument transformers**: Current Transformers and Potential Transformers – Ratio and Phase Angle Errors – Methods for Reduction of Errors-Design Considerations.
**Potentiometers:** Principle and Operation of D.C. Crompton‟s Potentiometer – Standardization – Measurement of unknown Resistance, Current, Voltage -AC Potentiometers: Polar and Coordinate types- Standardization – Applications.

**MODULE-5 Transducers**

Definition and classification - common transducers for measurement of displacement, velocity, flow, liquid level, force, pressure, strain and temperature -LVDT, electromagnetic and ultrasonic flow meters, piezoelectric force transducer, load cell, strain gauge- bridge configuration for four strain gauges, RTD, Thermistors, thermocouple, data acquisition system.

**Total : 48 hrs**

**Text Book(s):**

4. Electrical & Electronic Measurements and Instrumentation by AK Sawhney, Dhanpat Rai & Sons Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.-2017
5. J. B. Gupta - A course in Electronic and Electrical measurements and Instrumentation, S. K. Kataria Publication-2020
6.Electrical Measurements & Measuring Instruments by M.L.Anand (Author)-2014

**Reference Book(s):**

1 Electrical Measurements and Measuring Instruments (English, Paperback, F. C. Widdis, E. W. Golding) January 2011
2. Electrical & Electronic Measurement & Instrumentation by R. K. Rajput, 2nd Edition, S. Chand & Co., 2nd Edition, 2013.

## 3. POWER SYSTEM ARCHITECTURE

**MODULE – 1** **Non Renewable Generating Stations**

**Thermal Power plant:** Importance of electrical power generation-Sources of energy-Conventionaland non-conventional sources-Block Diagram of Thermal Power Station (TPS).
**Hydro Power plant:** Merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, Classification of the plants.
**Nuclear Power plant**: Introduction, Merits and demerits, selection of site, Nuclear reaction, Nuclearfuels, Nuclear plant and layout.

**MODULE-2** **Renewable Generating Stations**

**Solar Power Generation**: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker, Solar PV Systems. **Wind Power Generation**: Basic principles of wind energy conversion power in the wind-Forces on blades and thrust on turbines – Wind energy conversion – site selection considerations– types of wind energy collectors.
**Bio Energy:** Biomass conversion technologies , Bio gas generation , Factors affecting bio digestion or generation of gas , Classification of bio gas plants.

**MODULE-3** **Transmission Line Parameters**

Types of Conductors, Resistance For Solid Conductors – Skin Effect- Calculation of Inductance for Single Phase and Three Phase, Concept of GMR & GMD, Symmetrical and Asymmetrical Conductor Configuration with and without Transposition, Numerical Problems, Capacitance Calculations for Symmetrical and Asymmetrical Single and Three Phase, Effect of Ground on Capacitance.

**MODULE-4** **Modeling of Transmission Lines**

Classification of Transmission Lines and their equivalent circuits- Nominal-T, Nominal-π. Mathematical Solutions to Estimate Regulation and Efficiency. Evaluation of A,B,C,D Constants,Surge Impedance & itsLoading , Wavelengths and Propagation , Ferranti Effect , Charging Current.

**MODULE-5** **Performance of Transmission Line**

**Insulators:** Types of Insulators, String Efficiency and Methods for Improvement, and numerical problem. **Corona:** Corona Phenomenon, Factors Affecting Corona, Critical and disruptive Voltages and Power Loss, Radio Interference.**Sag and Tension Calculations:** Sag and Tension Calculations with Equal and Unequal Heights of Towers,Effect of Wind and Ice on Weight of Conductor, StringingChart, Sag Template .

**Total : 48 hrs**

**Text Book(s):**

1. Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A.Chakraborti, Dhanpat Rai &Co. Pvt. Ltd., 1999
2. Non Conventional Energy Sources by G.D. Rai, Khanna Publishers, 2000.

## 4. UTILIZATION OF ELECTRICAL ENERGY

**MODULE – 1 Electric Drives and Traction**

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear

**MODULE -2 Mechanics of Electric Traction**

Mechanics of Train Movement. Speed-Time Curves of Different Services – Trapezoidal and Quadrilateral Speed-Time Curves – Numerical Problems. Calculations of Tractive Effort, Power, Specific Energy Consumption, Adhesive Weight and Coefficient of Adhesion.

**MODULE-3 Illumination**

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapor lamps, fluorescent lamps –design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting – UPS- energy saving lamps, LED – working principle of air conditioning system.

**MODULE-4 Heating And Welding**

Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding - radiation welding.

**MODULE-5 Solar & Wind Energy Conversion System**

**Solar Energy Conversion System:** Introduction - solar constant – terrestrial solar radiation - solar radiation geometry – estimation of average solar radiation - physical principles of the conversion of solar radiation into heat – flat-plate collectors - transmissivity of cover system - energy balance equation and collector efficiency -concentrating collector - advantages and disadvantages of concentrating collectors.

**Wind Energy Conversion System:** Introduction - basic principles of wind energy conversion - site selection considerations - basic components of a WECS (Wind Energy Conversion System) - Classification of WECS - types of wind machines - analysis of aerodynamic forces acting on the blade

**Total : 48 hrs**

**Text Book(s):**

1. Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009.
2. N.V. Suryanarayana, “Utilisation of Electric Power”, Wiley Eastern Limited, New Age International Limited, 1993
3. J.B.Gupta, “Utilisation Electric power and Electric Traction”, S.K.Kataria and sons, 2000.

**Reference Book(s):**

1. Generation, distribution and utilization of electrical energy, C.L Wadhwa, Wiley Eastern Limited,1993
2. R.K.Rajput, Utilisation of Electric Power, Laxmi publications private Limited.,2007
3. H.Partab, Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Co., New Delhi-2004.
4. G.D.Rai,” Non-Conventional Energy sources”, Khanna publications Ltd.,New Delhi 1997

## 5. LINEAR CONTROL SYSTEMS

**MODULE – 1** **Introduction To Control Systems**

Examples & Classification of control systems, merits and demerits of Open Loop and closed loop control systems, Effects of positive and negative feedback Mathematical modelling and transfer function of Electrical and Mechanical systems, Analogous systems.
**Control System Components**: DC Servo motor, AC Servo motor , Synchro Transmitter & Receiver
**Block diagrams**: Block diagram representation of control systems, Block Diagram Reduction Rules .
**Signal flow graph**: Definitions, Reduction using Mason's gain formula.

**MODULE-2** **Time Response Analysis**

Standard test signals, Time response of first order and second order un damped, under damped, criticallydamped and over damped systems, Time domain specifications.
**Error Analysis:** Steady state Error**,** static error coefficient of type 0,1, 2 systems.

**MODULE-3** **Stability Analysis**

**Stability:** The concept of stability, Routh's stability criterion, limitations of Routh's stability. **Root locus plot**: The root locus concept, construction of root loci, effects of adding poles andzeros toG(s)H(s) on the root loci.

**MODULE-4** **Frequency Response Analysis**

Introduction, Frequency domain specifications, Bode plot, polar plot, Transfer function from the Bode Diagram, Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots.
**Compensation Techniques:** Lag, Lead, Lag-Lead Compensators.

**MODULE-5** **State Space Analysis**

**Introduction:** Concepts of state, state variables and state model, derivation of state models fromdifferential equations, Diagonalization.
**Solution of state equation:** Solving the Time invariant state Equations, State Transition Matrixand it's Properties. (2h)The concepts of controllability and observability.

**Total : 48 hrs**

**Text Book(s):**


1. "Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age InternationalPublishers,5th edition, 2007, Reprint 2012.
2. Control Systems by A. Anand Kumar, PHI Learning pvt. Ltd., second edition


**Reference Book(s):**


1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013
2. Modern Control Engineering, Katsuhiko Ogata, PEARSON, 1st Impression 2015.
3. Automatic Control Systems, Farid Golnaraghi and Benjamin. C. Kuo, WILEY, 9th Edition, 2010.