

Coimbatore-641 008



# CURRICULUM AND SYLLABI M. E POWER ELECTRONICS AND DRIVES

**Regulation 2022** 

# DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

#### VISION

To provide the students with high quality technical education in the field of Electrical and Electronics Engineering enabling them to become competent and responsible engineers with employability and entrepreneurial skills.

### **MISSION**

**M1: Equip** the students with adequate knowledge in the field of Electrical and Electronics Engineering and professional skills necessary to face the future challenges with confidence and courage.

**M2: Engineer** them to engage in research activities leading to innovative applications of technology.

M3: Enable them to become responsible citizens of the country with a willingness to serve the

society.

#### Programme Outcomes (POs)

At the time of their graduation students of Electrical and Electronics Engineering Programme should be in possession of the following Programme Outcomes

**PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex electrical engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze electrical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3.** Design/development of solutions: Design solutions for complex electrical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex electrical

engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9.** Individual and team work: Function effectively as an individual, and as a member orleader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability toengage in independent and life-long learning in the broadest context of technological change.

# **Program Educational Objectives (PEOs)**

**PEO1:** Graduates will have successful career in industry that meets the needs of Indian and multinational companies.

**PEO2:** Graduates will synthesize data and technical concepts for application to product design and to solve research problems.

**PEO3:** Graduates will work as a part of teams on multidisciplinary projects with good communication and interpersonal skills.

**PEO4:** Graduates will exercise their knowledge in mathematical, scientific and engineering fundamentals to formulate, analyze and solve engineering problems following ethical practices. **PEO5:** Graduates will exhibit life-long learning updating knowledge continuously.

| Mannin | a of | PO's | to | PFO's |
|--------|------|------|----|-------|
| wappin | y u  | FU 3 | ιυ | FEU 3 |

| Programme                 | Programme Outcomes |         |         |         |         |         |         |         |         |          |          |          |  |
|---------------------------|--------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|--|
| Educational<br>Objectives | P<br>0<br>1        | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PO1<br>2 |  |
| PEO 1                     | 3                  | 3       | 3       | 2       | 3       | 2       | 3       | 2       | 2       | 3        | 2        | 3        |  |
| PEO 2                     | 3                  | 3       | 3       | 2       | 3       | 2       | 3       | 2       | 2       | 3        | 3        | 3        |  |
| PEO 3                     | 2                  | 2       | 2       | 3       | 2       | 2       | 3       | 2       | 2       | 3        | 2        | 3        |  |
| PEO 4                     | 3                  | 3       | 3       | 2       | 3       | 2       | 2       | 2       | 2       | 3        | 3        | 2        |  |
| PEO 5                     | 2                  | 2       | 2       | 1       | 1       | 3       | 2       | 3       | 3       | 2        | 2        | 2        |  |

1 Reasonably agreed 2 Moderately agreed 3 Strongly agreed

# Program Specific Outcome (PSOs)

# After the successful completion of the B.E. Electrical and Electronics Engineering programme, the graduates will be able to:

**PSO1:** Analyze basic scientific concepts and provide solutions to Electrical and Electronics Engineering problems with a specific focus on emerging energy challenges.

**PSO2:** Use relevant software apply current techniques for data processing problems in the field of modern electronic systems for sustainable development.

**PSO3:** Develop products/software to cater to the societal & Industrial needs and adapt ethical values so as to become successful electrical engineering professionals.

| Year | Sem   | Course Code / Course   |   |   |   | Ρ | rogr | am ( | Outc | ome | es |    |    |    | Pro<br>Spe<br>Out | grar<br>cific | n<br>;<br>ies |
|------|-------|--|---|---|---|---|------|------|------|-----|----|----|----|----|-------------------|---------------|---------------|
|      |       | The  | 1 | 2 | 3 | 4 | 5    | 6    | 7    | 8   | 9  | 10 | 11 | 12 | 1                 | 2             | 3             |
|      |       | 22PM104 - Linear<br>Algebra, Transforms and<br>Numerical Methods | 3 | 2 | 1 | 1 | 0    | 0    | 0    | 0   | 0  | 1  | 0  | 2  | 0                 | 0             | 3             |
|      |       | 22PE101 - Analysis and<br>Design of Power<br>Converters          | 3 | 2 | 2 | 2 | 0    | 0    | 0    | 0   | 0  | 0  | 0  | 1  | 3                 | 0             | 0             |
|      | ter I | 22PE102 - Modelling and<br>Analysis of Electrical<br>Machines    | 2 | 2 | 1 | 1 | 0    | 0    | 0    | 0   | 0  | 1  | 0  | 2  | 3                 | 0             | 0             |
|      | emes  | 22PE5XX - Professional<br>Elective 1                             | 3 | 3 | 3 | 3 | 3    | 2    | 2    | 3   | 3  | 2  | 3  | 3  | 2                 | 3             | 3             |
|      | S     | 22PE5XX - Professional<br>Elective 2                             | 3 | 3 | 3 | 3 | 3    | 2    | 2    | 3   | 3  | 2  | 3  | 3  | 2                 | 3             | 3             |
|      |       | 22PE103 - Power<br>Converters Laboratory                         | 3 | 3 | 2 | 2 | 3    | 0    | 1    | 2   | 2  | 2  | 0  | 0  | 3                 | 0             | 3             |
|      |       | 22AC0XX - Audit I  | 3 | 3 | 3 | 3 | 3    | 2    | 2    | 3   | 2  | 3  | 3  | 2  | 3                 | 3             | 3             |
| -    |       | 22PE201 - Electric Drives<br>System                              | 3 | 2 | 1 | 0 | 0    | 0    | 0    | 0   | 0  | 0  | 0  | 3  | 0                 | 2             | 0             |
| Үеаі |       | 22PE202 - Electric<br>Vehicles and Power<br>Management           | 3 | 2 | 1 | 0 | 0    | 0    | 0    | 0   | 0  | 2  | 0  | 0  | 1                 | 3             | 0             |
|      | =     | 22PE203 - Modelling and<br>Design of SMPS                        | 3 | 2 | 1 | 1 | 0    | 0    | 0    | 0   | 0  | 1  | 0  | 2  | 3                 | 0             | 0             |
|      | ester | 22PE5XX - Professional<br>Elective 3                             | 3 | 3 | 3 | 3 | 3    | 2    | 2    | 3   | 3  | 2  | 3  | 3  | 2                 | 3             | 3             |
|      | Sem   | 22PE5YY - Professional<br>Elective 4                             | 3 | 3 | 3 | 3 | 3    | 2    | 2    | 3   | 3  | 2  | 3  | 3  | 2                 | 3             | 3             |
|      |       | 22PE204 - Mini Project<br>with Seminar                           | 3 | 3 | 3 | 3 | 3    | 2    | 2    | 3   | 2  | 3  | 3  | 2  | 3                 | 3             | 3             |
|      |       | 22PE205 - Electrical<br>Drives Laboratory                        | 3 | 2 | 1 | 1 | 0    | 0    | 1    | 2   | 2  | 2  | 0  | 0  | 3                 | 0             | 3             |
|      |       | 22AC0XX - Audit II   | 3 | 3 | 3 | 3 | 3    | 2    | 2    | 3   | 2  | 3  | 3  | 2  | 3                 | 3             | 3             |

| Year    | Sem         | Course Code /                             |   | Program Outcomes |   |   |   |   |   |   |   |    |    |    | Program<br>Specific<br>Outcomes |   |   |
|---------|-------------|---|---|------------------|---|---|---|---|---|---|---|----|----|----|---------------------------------|---|---|
|         |             | CourseTitle                               | 1 | 2                | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                               | 2 | 3 |
| Year II | E           | 22PE5XX/YY-<br>Professional<br>Elective 5 | 3 | 3                | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2  | 3  | 3  | 2                               | 3 | 3 |
|         | nester      | 22OEZZZ -<br>Open Elective                | 3 | 3                | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2  | 3  | 3  | 2                               | 3 | 3 |
|         | Sem         | 22PE301 -<br>Dissertation<br>Phase - I    | 3 | 3                | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3  | 3  | 2  | 3                               | 3 | 3 |
|         | Semester IV | 22PE401 -<br>Dissertation<br>Phase - II   | 3 | 3                | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3  | 3  | 2  | 3                               | 3 | 3 |

## PG CURRICULUM DESIGN UNDER REGULATION 2022

# M.E. POWER ELECTRONICS AND DRIVES

#### DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

| SEME   | SEMESTER I       |  |        |                   |    |         |      |  |  |  |  |  |  |
|--------|------------------|--|--------|-------------------|----|---------|------|--|--|--|--|--|--|
| S.No   | Course<br>Code   | Course   | L/T/P  | Contact<br>Hrs/Wk | С  | Ext/Int | Cat. |  |  |  |  |  |  |
| Theor  | у                |  |        |                   |    |         |      |  |  |  |  |  |  |
| 1      | 22PM104          | Linear Algebra, Transforms and Numerical Methods | 3/0/0  | 3                 | 3  | 60/40   | BSC  |  |  |  |  |  |  |
| 2      | 22PE101          | Analysis and Design of<br>Power Converters       | 3/0/0  | 3                 | 3  | 60/40   | PCC  |  |  |  |  |  |  |
| 3      | 22PE102          | Modelling and Analysis of<br>Electrical Machines | 3/0/0  | 3                 | 3  | 60/40   | PCC  |  |  |  |  |  |  |
| 4      | 22PE5XX          | Professional Elective 1                          | 3/0/0  | 3                 | 3  | 60/40   | PEC  |  |  |  |  |  |  |
| 5      | 22PE5XX          | Professional Elective 2                          | 3/0/0  | 3                 | 3  | 60/40   | PEC  |  |  |  |  |  |  |
| Practi | cal              |  |        |                   |    |         |      |  |  |  |  |  |  |
| 6      | 22PE103          | Power Converters<br>Laboratory                   | 0/0/4  | 4                 | 2  | 40/60   | PCC  |  |  |  |  |  |  |
| Manda  | Mandatory Course |  |        |                   |    |         |      |  |  |  |  |  |  |
| 7      | 22AC101          | Audit I  | 2/0/0  | 2                 | -  | -       | -    |  |  |  |  |  |  |
|        |                  | Total  | 17/0/4 | 21                | 17 | 600     | -    |  |  |  |  |  |  |

| SEME   | SEMESTER II      |   |        |                   |    |         |      |  |  |  |  |  |  |
|--|------------------|---|--------|-------------------|----|---------|------|--|--|--|--|--|--|
| S.No   | Course<br>Code   | Course                                    | L/T/P  | Contact<br>Hrs/Wk | С  | Ext/Int | Cat. |  |  |  |  |  |  |
| Theor  | у                |   |        |                   |    |         |      |  |  |  |  |  |  |
| 1         22PE201         Electric Drives System         3/0/0         3         3         60/40         PCC |                  |   |        |                   |    |         |      |  |  |  |  |  |  |
| 2  | 22PE202          | Electric Vehicles and Power<br>Management | 3/0/0  | 3                 | 3  | 60/40   | PCC  |  |  |  |  |  |  |
| 3  | 22PE203          | Modelling and Design of<br>SMPS           | 3/0/0  | 3                 | 3  | 60/40   | PCC  |  |  |  |  |  |  |
| 4  | 22PE5XX          | Professional Elective 3                   | 3/0/0  | 3                 | 3  | 60/40   | PEC  |  |  |  |  |  |  |
| 5  | 22PE5YY          | Professional Elective 4                   | 3/0/0  | 3                 | 3  | 60/40   | PEC  |  |  |  |  |  |  |
| Mini F   | Project          |   |        |                   |    |         |      |  |  |  |  |  |  |
| 6  | 22PE204          | Mini Project with Seminar                 | 0/0/4  | 4                 | 2  | 40/60   | PW   |  |  |  |  |  |  |
| Pract  | lical            |   |        |                   |    |         |      |  |  |  |  |  |  |
| 7  | 22PE205          | Electrical Drives Laboratory              | 0/0/4  | 4                 | 2  | 40/60   | PCC  |  |  |  |  |  |  |
| Mand   | Mandatory Course |   |        |                   |    |         |      |  |  |  |  |  |  |
| 8  | 22AC201          | Audit II                                  | 2/0/0  | 2                 | -  | -       | -    |  |  |  |  |  |  |
|  |                  | Total                                     | 17/0/8 | 25                | 19 | 800     | -    |  |  |  |  |  |  |

| SEMI | ESTER III      |                         |        |                   |    |         |      |
|------|----------------|-------------------------|--------|-------------------|----|---------|------|
| S.No | Course<br>Code | Course                  | L/T/P  | Contact<br>Hrs/Wk | С  | Ext/Int | Cat. |
| Theo | ry             |                         |        |                   |    |         |      |
| 1    | 22PE5XX/YY     | Professional Elective 5 | 3/0/0  | 3                 | 3  | 60/40   | PEC  |
| 2    | 220EZZZ        | Open Elective           | 3/0/0  | 3                 | 3  | 60/40   | OEC  |
| Theo | ry Cum Labor   | atory                   |        |                   |    |         |      |
| 3    | 22PE301        | Dissertation Phase - I  | 0/0/20 | 20                | 10 | 40/60   | PW   |
|      |                | Total                   | 6/0/20 | 26                | 16 | 300     |      |

| SEM   | ESTER IV       |                         |       |        |                   |    |           |      |
|-------|----------------|-------------------------|-------|--------|-------------------|----|-----------|------|
| S.No  | Course<br>Code | Course                  |       | L/T/P  | Contact<br>Hrs/Wk | С  | Ext./Int. | Cat. |
| Theor | у              |                         |       |        |                   |    |           |      |
| 1     | 20PE401        | Dissertation Phase - II |       | 0/0/32 | 32                | 16 | 40/60     | PW   |
|       |                |                         | Total | 0/0/32 | 32                | 16 | 100       |      |

# SCHEME OF CREDIT DISTRIBUTION-SUMMARY

| S No  | Stroom                                 |    | Cr | edits/Se | mester |         | С      | ourses               |     |       |
|-------|--|----|----|----------|--------|---------|--------|----------------------|-----|-------|
| 5.110 | Stream                                 | I  | н  | ш        | IV     | Credits | Theory | Theory<br>Cum<br>Lab | Lab | %     |
| 1.    | Basic Science<br>Courses (BSC)         | 3  |    |          |        | 3       | 1      |                      |     | 4.41  |
| 2.    | Professional Core<br>Courses (PCC)     | 8  | 11 |          |        | 19      | 5      |                      | 2   | 27.94 |
| 3.    | Professional Elective<br>Courses (PEC) | 6  | 6  | 3        |        | 15      | 5      |                      |     | 22.05 |
| 4.    | Open Elective Courses<br>(OEC)         |    |    | 3        |        | 03      | 1      |                      |     | 4.41  |
| 5.    | Project Work (PW)                      |    | 2  | 10       | 16     | 28      | 3      |                      | 3   | 41.17 |
| 6.    | Audit Courses(AC)                      | 0  | 0  |          |        | 0       | 2      |                      |     | -     |
|       | Total                                  | 17 | 19 | 16       | 16     | 68      | 17     |                      | 5   | 100   |

# CURRICULUM STRUCTURE FOR UG DEGREE PROGRAMME

| S.No | Course Work - Subject Area          | AICTE Suggested<br>Breakdown of Credits | SKCET<br>Credits |
|------|-------------------------------------|---|------------------|
| 1.   | Basic Science Courses (BSC)         | -                                       | 03               |
| 2.   | Professional Core Courses (PCC)     | 22                                      | 19               |
| 3.   | Professional Elective Courses (PEC) | 15                                      | 15               |
| 4.   | Open Elective Courses (OEC)         | 03                                      | 03               |
| 5.   | Project Work (PW)                   | 28                                      | 28               |
| 6.   | Audit Courses(AC)                   | -                                       | -                |
|      | Total                               | 68                                      | 68               |

# **BASIC SCIENCE COURSES (03 Credits)**

| S.No | Course<br>Code | Course Title  | L/T/P | Contact<br>Hrs/Wk | С | Cat. |
|------|----------------|---|-------|-------------------|---|------|
| 1.   | 22PM104        | Linear Algebra, Transforms and<br>Numerical Methods | 3/0/0 | 3                 | 3 | BSC  |

# PROFESSIONAL CORE COURSES (19 Credits)

| S.No | Course<br>Code | Course Title                                     | L/T/P | Contact<br>Hrs/Wk | С | Cat. |
|------|----------------|--|-------|-------------------|---|------|
| 1.   | 22PE101        | Analysis and Design of Power<br>Converters       | 3/0/0 | 3                 | 3 | PCC  |
| 2.   | 22PE102        | Modelling and Analysis of Electrical<br>Machines | 3/0/0 | 3                 | 3 | PCC  |
| 3.   | 22PE103        | Power converters Laboratory                      | 0/0/4 | 4                 | 2 | PCC  |
| 4.   | 22PE201        | Electric Drives System                           | 3/0/0 | 3                 | 3 | PCC  |
| 5.   | 22PE202        | Electric Vehicles and Power<br>Management        | 3/0/0 | 3                 | 3 | PCC  |
| 6.   | 22PE203        | Modeling and Design of SMPS                      | 3/0/0 | 3                 | 3 | PCC  |
| 8.   | 22PE205        | Electrical Drives Laboratory                     | 0/0/4 | 4                 | 2 | PCC  |

# PROFESSIONAL ELECTIVE COURSES (18 Credits)

| S.No | Course<br>Code | Course<br>Title   | L/T/P | Contact<br>hrs/wk | С | Cat. |
|------|----------------|---|-------|-------------------|---|------|
|      |                | Group I - Elective List                                   |       |                   |   |      |
| 1.   | 22PE501        | Distributed Generation and Micro<br>Girds                 | 3/0/0 | 3                 | 3 | PEC  |
| 2.   | 22PE502        | Power Quality   | 3/0/0 | 3                 | 3 | PEC  |
| 3.   | 22PE503        | Grid Integration of Renewable Energy Sources              | 3/0/0 | 3                 | 3 | PEC  |
| 4.   | 22PE504        | Power Semiconductor Devices and<br>Modelling              | 3/0/0 | 3                 | 3 | PEC  |
| 5.   | 22PE505        | Modern Rectifiers and Resonant<br>Converters              | 3/0/0 | 3                 | 3 | PEC  |
| 6.   | 22PE506        | Digital Control of Power Electronics<br>and Drive Systems | 3/0/0 | 3                 | 3 | PEC  |
| 7.   | 22PE507        | Special Electrical Machines                               | 3/0/0 | 3                 | 3 | PEC  |
| 8.   | 22PE508        | Power System Restructuring and<br>Deregulation            | 3/0/0 | 3                 | 3 | PEC  |
| 9.   | 22PE509        | Static VAR Controllers and Harmonic<br>Filtering          | 3/0/0 | 3                 | 3 | PEC  |
| 10.  | 22PB516        | Optimization Techniques                                   | 3/0/0 | 3                 | 3 | PEC  |
| 11.  | 22PE510        | Power Electronics for Renewable<br>Energy Systems         | 3/0/0 | 3                 | 3 | PEC  |
|      |                | Group II - Elective List                                  |       |                   |   |      |
| 1.   | 22PE511        | MEMS Design: Sensors and<br>Actuators                     | 3/0/0 | 3                 | 3 | PEC  |
| 2.   | 22PE512        | Electrical Systems in Wind Energy                         | 3/0/0 | 3                 | 3 | PEC  |
| 3.   | 22PE513        | Fuzzy Systems   | 3/0/0 | 3                 | 3 | PEC  |
| 4.   | 22PE514        | Machine Learning Applications in<br>Power Sytem           | 3/0/0 | 3                 | 3 | PEC  |
| 5.   | 22PE515        | System Theory   | 3/0/0 | 3                 | 3 | PEC  |
| 6.   | 22PE516        | DSP Based System Design                                   | 2/0/2 | 3                 | 3 | PEC  |
| 7.   | 22PE517        | HVDC and FACTS  | 2/0/2 | 3                 | 3 | PEC  |
| 8.   | 22PE518        | Machine Learning and Deep Learning                        | 3/0/0 | 3                 | 3 | PEC  |
| 9.   | 22PB517        | Internet of Everything                                    | 3/0/0 | 3                 | 3 | PEC  |
| 10.  | 22PB519        | Research Methodology and IPR                              | 3/0/0 | 3                 | 3 | PEC  |
| 11.  | 22PE520        | Advanced Microcontrollers Based<br>System                 | 3/0/0 | 3                 | 3 | PEC  |

### **OPEN ELECTIVE COURSE (3 Credits)**

| S.No | Course<br>Code | Course                                     | L/T/P | Contact<br>hrs/wk | С | Cat. |
|------|----------------|--|-------|-------------------|---|------|
| 1.   | 22PE001        | Waste to Energy                            | 3/0/0 | 3                 | 3 | OEC  |
| 2.   | 22PF001        | Business Analytics                         | 3/0/0 | 3                 | 3 | OEC  |
| 3.   | 22PD001        | Fundamentals of Industrial Safety          | 3/0/0 | 3                 | 3 | OEC  |
| 4.   | 22PD002        | Operational Research                       | 2/1/0 | 3                 | 3 | OEC  |
| 5.   | 22PC001        | Cost Management of Engineering<br>Projects | 3/0/0 | 3                 | 3 | OEC  |
| 6.   | 22PC002        | Fundamentals of Composite Materials        | 3/0/0 | 3                 | 3 | OEC  |

### AUDIT COURSES (0 credits)

| S.<br>No. | Course<br>Code | Course Title  | L/T/P | Contact<br>hrs./Wk. | С | Cat. |
|-----------|----------------|---|-------|---------------------|---|------|
| 1.        | 22AC001        | English for Research Paper Writing                            | 2/0/0 | 2                   | 0 | AC   |
| 2.        | 22AC002        | Disaster Management   | 2/0/0 | 2                   | 0 | AC   |
| 3.        | 22AC003        | Sanskrit for Technical Knowledge                              | 2/0/0 | 2                   | 0 | AC   |
| 4.        | 22AC004        | Value Education   | 2/0/0 | 2                   | 0 | AC   |
| 5.        | 22AC005        | Constitution of India   | 2/0/0 | 2                   | 0 | AC   |
| 6.        | 22AC006        | Pedagogy Studies  | 2/0/0 | 2                   | 0 | AC   |
| 7.        | 22AC007        | Stress Management by Yoga                                     | 2/0/0 | 2                   | 0 | AC   |
| 8.        | 22AC008        | Personality Development through Life<br>Enlightenment Skills. | 2/0/0 | 2                   | 0 | AC   |

#### SEMESTER WISE CREDIT DISTRIBUTION

| Semester | I  | II |    | IV | Total |
|----------|----|----|----|----|-------|
| Credits  | 17 | 19 | 16 | 16 | 68    |

# **Total Credits: 68**

 L: Lecture
 T: Tutorial
 P: Practical
 C: Credit
 Cat.: Category
 Hrs/Wk: Hours/Week

 BSC
 : Basic Science Courses
 PW
 : Project Work

 PCC
 : Professional Core Courses
 PEC
 : Professional Elective Courses

 OEC
 :Open Elective Courses
 AC
 : Audit Course

| Nature o  | f Course J (Problem Analytical)   |  |  |  |  |  |  |  |  |  |
|---|---|--|--|--|--|--|--|--|--|--|
| Course 0  | Dbjectives:   |  |  |  |  |  |  |  |  |  |
| 1   | To acquire the knowledge of Vector spaces and Inner product spaces to har   | ndle   |  |  |  |  |  |  |  |  |
|   | problems.   | 6  |  |  |  |  |  |  |  |  |
|   | To acquaint the student with Fourier, transform techniques used in which the  | e functions  |  |  |  |  |  |  |  |  |
| 2   | transform techniques used in analysis for continuous time systems and 7 transform   |  |  |  |  |  |  |  |  |  |
|   | echniques used in analysis for discrete time systems.   |  |  |  |  |  |  |  |  |  |
| З   | To solve problems on differential equations using Numerical techniques  |  |  |  |  |  |  |  |  |  |
| Course (  | Dutcomes:   |  |  |  |  |  |  |  |  |  |
| Upon co   | mpletion of the course, students shall have ability to  |  |  |  |  |  |  |  |  |  |
| 0104.4  | Apply the concept of Vector spaces and Inner product spaces in the field  |  |  |  |  |  |  |  |  |  |
| C104.1  | of Communication Engineering.   | [AP]   |  |  |  |  |  |  |  |  |
| C104.2  | Apply the techniques in Transforms.   | [AP]   |  |  |  |  |  |  |  |  |
| C104.3  | Apply the effective numerical methods for finding the solution of differential equations.   | [AP]   |  |  |  |  |  |  |  |  |
| Course 0  | Contents:   |  |  |  |  |  |  |  |  |  |
| Module 1  | I: Linear Algebra   | 15 Hrs   |  |  |  |  |  |  |  |  |
| of Linea<br>Dimensio<br>bases-Le<br>Orthogon                  | r Transformation - Linear Dependent and Independent set of vectors-E<br>ns– Inner product Spaces-Properties - Cauchy-Schwarz inequality– Ort<br>ngth and Orthogonality-Orthogonal sets-Orthogonal projections-Gran<br>alization Process (Excluding proof of theorems)   | asis and<br>honormal<br>h-Schmidt                        |  |  |  |  |  |  |  |  |
| Module 2  | 2: Transforms   | 15 Hrs   |  |  |  |  |  |  |  |  |
| Fourier tr<br>Inverse F<br>simple p<br>equations<br>Convoluti | ansform pairs-Sine and Cosine transforms — Convolution theorem-Parseval<br>Fourier transforms. Laplace transform –simple problems- Inverse Laplace<br>problems- Partial fractions and Convolution theorem-Solving ordinary<br>s using Laplace transforms - Z-transform - elementary properties-Inverse Z-<br>tion theorem — Solution of difference equation using Ztransform. | 's identity-<br>transform-<br>differential<br>transform- |  |  |  |  |  |  |  |  |
| Module 3<br>Boundary<br>Solution<br>conductio                 | <b>B: Numerical Solution of Differential Equations</b><br>value problems for ODE –Euler method- RK method- Numerical solution<br>of Laplace and Poisson equations-Liebmann's iteration process-Solution<br>on equation by Schmidt explicit formula and Crank-Nicolson implicit scheme.  | <b>15 Hrs</b><br>of PDE-<br>of heat                      |  |  |  |  |  |  |  |  |
|   | Total Hours   | 45   |  |  |  |  |  |  |  |  |
| Text Boo  | vks:  |  |  |  |  |  |  |  |  |  |
| 1   | David C Lay, "Linear Algebra and its Applications", 5th Edition, Pearson Asia, NewDelhi,2017.   | Education  |  |  |  |  |  |  |  |  |
| 2   | Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley Inc   | dia, 2017.   |  |  |  |  |  |  |  |  |
| 3   | Jain, M.K., Iyengar, S.R.K., and Jain, R.K., "Numerical Methods for So<br>Engineering computation", VI Edition, New Age International, 2017.  | cientific &  |  |  |  |  |  |  |  |  |
| Reference   | ce Books:   |  |  |  |  |  |  |  |  |  |
| 1   | Bali, N.P. and Manish Goyal, "A Text Book of Engineering", IX Edition, Laksh  | nmi  |  |  |  |  |  |  |  |  |
| P2022   | M.E. Bower Electronics and Drives   | Dage 11  |  |  |  |  |  |  |  |  |

Linear Algebra, Transforms and Numerical Methods

22PM104

3/0/0/3

|         | Publications (P) Limited, New Delhi, 2016.  |  |  |  |  |  |  |
|---------|---|--|--|--|--|--|--|
| 2       | Rajasekaran S., "Numerical methods in Science and Engineering- A Practical        |  |  |  |  |  |  |
| 2       | Approach", 4nd edition, Wheeler Publishing, 2011.                                 |  |  |  |  |  |  |
| 2       | Grewal, B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publications, |  |  |  |  |  |  |
| 3       | 2017.   |  |  |  |  |  |  |
| Web Ref | Web References:   |  |  |  |  |  |  |
| 1       | http:// http://nptel.ac.in/courses/111104075/DOE                                  |  |  |  |  |  |  |
| 2       | http:// http://nptel.ac.in/courses/122104019/numerical-analysis                   |  |  |  |  |  |  |
| 3       | https://www.mooc-list.com/course/numerical-methods-engineers-saylororg            |  |  |  |  |  |  |
| 4       | https://www.canvas.net/browse/usflorida/courses/numerical-methods                 |  |  |  |  |  |  |
| 5       | http://nptel.ac.in/upcoming_courses.php   |  |  |  |  |  |  |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |   |                    |    |  |  |  |  |  |  |  |
|---|---|--------------------|----|--|--|--|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model  |                    |    |  |  |  |  |  |  |  |
| Course<br>Outcome                                       | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                    |    |  |  |  |  |  |  |  |
| C104.1  | Apply   | Online Quiz        | 20 |  |  |  |  |  |  |  |
| C104.2  | Apply   | Class Presentation | 20 |  |  |  |  |  |  |  |
| C104.3  | Apply   | Assignment         | 40 |  |  |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |  |  |  |
| Remember   | 10                      | 10                      | 10                                |  |  |  |  |  |  |  |
| Understand   | 10                      | 10                      | 10                                |  |  |  |  |  |  |  |
| Apply  | 60                      | 60                      | 60                                |  |  |  |  |  |  |  |
| Analyse  | 20                      | 20                      | 20                                |  |  |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |               |                                |                                 |                         |  |  |  |  |
|---|--------------------------------|---------------------------------|---------------|--------------------------------|---------------------------------|-------------------------|--|--|--|--|
|   | End                            |                                 |               |                                |                                 |                         |  |  |  |  |
| CA 1 : 100 Marks CA 2 : 100 Marks                           |                                |                                 |               |                                |                                 | Semester<br>Examination |  |  |  |  |
| SA 1  | FA 1 (40 Marks)                |                                 | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)                   |  |  |  |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |  |  |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C104.1           | 3                 | 1       | 1       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C104.2           | 3                 | 2       | 2       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C104.3           | 3                 | 2       | 1       |         |         |         |         |         |         |          |          | 3        |          | 2        |          |
| 1                | Reasonably Agreed |         | 2       | Ν       | loder   | ately   | Agre    | ed      | 3       |          | Strong   | y Agree  | ed       |          |          |

| 22PE101   |  | Analysis and Design of Power Converters  | 3/0/0/3   |  |  |  |  |  |  |  |
|---|--|--|---|--|--|--|--|--|--|--|
| Nature of   | Course   | G (Theory analytical)  |   |  |  |  |  |  |  |  |
| Course P  | re-requisites  | Power Electronics  |   |  |  |  |  |  |  |  |
| Course C  | )bjectives:  |  |   |  |  |  |  |  |  |  |
| 1   | To provide the converters.   | electrical circuit concepts behind the different working modes   | s of power  |  |  |  |  |  |  |  |
| 2   | To equip with required skills to derive the criteria for the design of power converters.   |  |   |  |  |  |  |  |  |  |
| 3   | To analyze and comprehend the various operating modes of different configurations of Power converters.   |  |   |  |  |  |  |  |  |  |
| 4   | To design diffe  | erent power converters.  |   |  |  |  |  |  |  |  |
| Course C<br>Upon coi  | Outcomes:<br>mpletion of the   | e course, students shall have ability to   |   |  |  |  |  |  |  |  |
| C101.1  | Understand th  | e function of various power converter circuits.  | [U]   |  |  |  |  |  |  |  |
| C101.2  | Analyze the o  | peration of rectifier circuits and design of converter circuits.   | [A]   |  |  |  |  |  |  |  |
| C101.3  | Analyze the or   | peration and circuit design of DC-DC converters.   | [A]   |  |  |  |  |  |  |  |
| C101.4  | Analyze the w  | orking of inversion circuits and its design, fitness in verter harmonics.  | [A]   |  |  |  |  |  |  |  |
| C101.5  | Understand th  | e concepts of frequency conversion circuits.   | [U]   |  |  |  |  |  |  |  |
| Course C  | contents:  |  |   |  |  |  |  |  |  |  |
| Analysis<br>circuit Sin<br>operating<br>considera<br><b>Module 2</b><br>Analysis<br>Boost cor<br>strategies<br><b>Module 3</b><br>Single ph<br>control ar<br>multilevel<br>Single and | of power semic<br>ngle-Phase and<br>domains of t<br>ations. Design of<br><b>C to DC Co</b><br>and design of I<br>nverters, Buck-E<br>- Introduction to<br><b>C AC Converte</b><br>ase and three p<br>ad harmonic min<br>inverter - single<br>d three phase A | A conductor switched circuits with R, L, RL, RLE loads. Battery<br>d Three-Phase AC to DC converters-Half controlled confi<br>three phase full converters and semi-converters. Reacting<br>f converter circuits-Snubber circuit design-Control circuit strate<br><b>nverters</b><br>DC to DC converters - Control of DC-DC converters: Buck of<br>Boost converters, Cuk converters. Chopper circuit design-Control<br>or resonant converter.<br><b>rs</b><br>phase inverters. Voltage source and Current source inverters<br>nimization in inverters. Inverter circuit design -SVPWM-Intro<br>e phase and three phase cyclo converters - Control circuit s<br>aC Voltage regulators. | <ul> <li>charging gurations-<br/>ve power egies.</li> <li><b>15 Hrs</b> converters, ntrol circuit</li> <li><b>15 Hrs</b> s. Voltage duction to strategies-</li> </ul> |  |  |  |  |  |  |  |
|   |  | Total Hours  | 45  |  |  |  |  |  |  |  |
| Text Boo  | ks:  |  |   |  |  |  |  |  |  |  |
| 1   | Rashid M.H., "F<br>India, 3rd Editio   | Power Electronics Circuits, Devices and Applications ", Prention, New Delhi, 2013  | ce Hall   |  |  |  |  |  |  |  |
| 2   | 2 Ned Mohan, Undeland and Robbin, "Power Electronics: Converters, Application and Design", John's Wiley and sons, 3rd Edition 2007.  |  |   |  |  |  |  |  |  |  |
| 3   | Sen PC,"Mode   | rn Power Electronics ", Wheeler publishing Co, McGraw Hill 2   | 007.  |  |  |  |  |  |  |  |
| Referenc  | e Books:   |  |   |  |  |  |  |  |  |  |
| 1   | Philip T. krein,   | "Elements of Power Electronics" Oxford University Press, 201   | 2.  |  |  |  |  |  |  |  |
| 2   | P.S. Bhimbra, '  | "Power Electronics", Khanna Publishers, Fifth edition, 2012.   |   |  |  |  |  |  |  |  |
| Web Refe  | erences:   |  |   |  |  |  |  |  |  |  |
| 1   | https://nptel.ac   | .in/courses/108107128/   |   |  |  |  |  |  |  |  |
| 2   | https://nptel.ac   | .in/courses/108101126/   |   |  |  |  |  |  |  |  |

| 3 | https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334- |
|---|--|
|   | powerelectronics-spring-2007/lecture-notes/                                    |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |  |                    |    |  |  |  |  |  |
|---|--|--------------------|----|--|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model |                    |    |  |  |  |  |  |
| Course<br>Outcome                                       | FA (16%)<br>[80 Marks]                       |                    |    |  |  |  |  |  |
| C101.1  | Understand                                   | Online Quiz        | 20 |  |  |  |  |  |
| C101.2  | Analyze                                      | Class Presentation | 20 |  |  |  |  |  |
| C101.3  | Understand                                   | Simulation Program | 20 |  |  |  |  |  |
| C101.4  | Analyze                                      | Sinulation Frogram | 20 |  |  |  |  |  |
| C101.5  | Understand                                   | Assignment         | 20 |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |  |
| Remember   | 20                      | 20                     | 20                                |  |  |  |  |
| Understand   | 20                      | 20                     | 20                                |  |  |  |  |
| Apply  | 30                      | 30                     | 30                                |  |  |  |  |
| Analyse  | 30                      | 30                     | 30                                |  |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |  |
| Create   | -                       | -                      | _                                 |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |                       |                                |                                 |             |  |
|---|--------------------------------|---------------------------------|-----------------------|--------------------------------|---------------------------------|-------------|--|
|   | End                            |                                 |                       |                                |                                 |             |  |
| CA 1 : 100 Marks CA 2 : 100 Marks                           |                                |                                 |                       |                                | Semester<br>Examination         |             |  |
| SA 1  | FA 1 (40 Marks)                |                                 | SA 2                  | FA 2 (4                        | 0 Marks)                        | (60%)       |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | SA 2<br>(60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C101.1           | 3                 | 1       | 1       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C101.2           | 3                 | 2       | 2       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C101.3           | 3                 | 2       | 1       |         |         |         |         |         |         |          |          | 3        |          | 2        |          |
| C101.4           | 3                 | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| C101.5           | 3                 | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reasonably Agreed |         | 2       | Ν       | loder   | ately   | Agre    | ed      | 3       |          | Strongl  | y Agree  | ed       |          |          |

| 22PE102  | M  | odelling and Analysis of Electrical Machines  | 3/0/0/3  |  |  |  |  |  |  |
|--|--|---|--|--|--|--|--|--|--|
| Nature c   | of Course  | G (Theory Analytical)   |  |  |  |  |  |  |  |
| Course   | Pre-requisites   | DC Machines and Transformers, Synchronous and Induction   | n Machines   |  |  |  |  |  |  |
| Course   | Course Objectives:   |   |  |  |  |  |  |  |  |
| 1  | To impart the k  | nowledge on Electromagnetic Energy Conversion.  |  |  |  |  |  |  |  |
| 2  | To make clear  | To make clear understanding about the concept of Reference frame theory   |  |  |  |  |  |  |  |
| 3  | To provide the   | knowledge about the dynamic performance of DC machines  |  |  |  |  |  |  |  |
| Course Upon co   | Outcomes:  | course students shall have ability to   |  |  |  |  |  |  |  |
| C102 1   | Know about Ele   | ctromagnetic Energy Conversion  | [P]  |  |  |  |  |  |  |
| C102.1   | Understand the   | concept of Reference frame theory   |  |  |  |  |  |  |  |
| C102.2   | Analyze about C  | C machines with dynamic performance   |  |  |  |  |  |  |  |
| 0102.3   |  |   |  |  |  |  |  |  |  |
| 0102.4   | Apply reference  | Trame theory on Induction machines.   |  |  |  |  |  |  |  |
| C102.5   | Apply reference  | frame theory on Synchronous machines.   | [AP]   |  |  |  |  |  |  |
| Course   | Contents:  |   |  |  |  |  |  |  |  |
| <b>Module</b><br>General<br>single an  | 1: Principles of<br>expression of s<br>id doubly excited   | Electromagnetic Energy Conversion<br>tored magnetic energy, co-energy and force/ torque - Exan<br>system - Air gap MMF - winding inductances.   | <b>15 Hrs</b><br>nple using  |  |  |  |  |  |  |
| Module Static ar<br>frames -<br>Balanced<br>of referen<br>permane<br>by Lapla<br>machines<br>Module S<br>Induction<br>- Voltage<br>operation<br>variations<br>and torque<br>equations<br>performa<br>criterion | 2: Reference Fr<br>ad rotating refere-<br>Transformation<br>d steady state pl<br>nce. Direct curre<br>and magnet and s<br>ice transformations.<br>3: Symmetrical<br>machines-volta<br>and torque equa<br>and torque equa<br>b - Free accelera<br>s-Computer simula<br>ue equations - S<br>s - Rotor angle -<br>nce for three ph<br>- Computer simula | rame Theory and DC Machines<br>ence frames - Transformation of variables-Commonly used<br>in between reference frames - Transformation of a balar<br>hasor and voltage equations - Variables observed from seve<br>ent machines -Voltage and torque equations - Dynamic charac-<br>shunt DC motors - State equations - Solution of dynamic ch<br>on - digital computer simulation of permanent magnet and<br><b>Induction and Synchronous Machines</b><br>ge and torque equations - Equations of transformation for rol<br>nations in arbitrary reference frame variables - Analysis of ste<br>ation characteristics - Analysis of dynamic performance for lo<br>ulation in the arbitrary reference frame. Synchronous machines<br>Stator voltage equation in arbitrary reference for load torque variables<br>- Analysis of dynamic performance for load torque variations<br>mase fault - Transient stability limit - Critical clearing time - E<br>lation. | 15 Hrs<br>reference<br>aced set -<br>aral frames<br>cteristics of<br>aracteristic<br>shunt DC<br>15 Hrs<br>or circuits<br>ady state<br>ad torque<br>s-Voltage<br>s - Park's<br>a-Dynamic<br>iqual area |  |  |  |  |  |  |
| Text Bo  | oks:   | I otal Hours  | 45   |  |  |  |  |  |  |
|  |  | eg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, "Analysis o   | of Electric  |  |  |  |  |  |  |
| 1  | Machinery and I  | Drive Systems", Wiley IEEE Press, Third Edition, 2013.  |  |  |  |  |  |  |  |
| 2  | A.E. Fitzgerald.,<br>McGraw-Hill Pu  | Charles Kingsley. Jr., Stephen D. Umans, 'Electric Machinery blishing Co-Ltd, 2015.   | r, Tata  |  |  |  |  |  |  |
| Referen  | ce Books:  |   |  |  |  |  |  |  |  |
| 1  | R. Krishnan, "El<br>Education India;   | ectric Motor Drives, Modeling, Analysis and Control", Pearsor<br>; 1st edition, 2015.   | ۱  |  |  |  |  |  |  |
|  |  |   |  |  |  |  |  |  |  |

| 2     | P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 5th |  |  |  |  |  |
|-------|--|--|--|--|--|--|
| Z     | Edition,2013.  |  |  |  |  |  |
| 2     | Ned Mohan, "Advanced Electric Drives: Analysis, Control, and Modeling Using      |  |  |  |  |  |
| 3     | MATLAB / Simulink", Wiley & Sons, 1st Edition, 2014.                             |  |  |  |  |  |
| Web R | Web References:  |  |  |  |  |  |
| 1     | http://people.ece.umn.edu/users/riaz/macsim/info.pdf                             |  |  |  |  |  |
| 2     | https://ece.mst.edu/media/academic/ece/documents/12_Permanent_Magnet_DC_Machin   |  |  |  |  |  |
| 2     | e_Simulation_in_MATLAB_Simulink.pdf  |  |  |  |  |  |
| 3     | http://researchpub.org/journal/jac/number/vol2-no1/vol2-no1-5.pdf                |  |  |  |  |  |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |   |                    |    |  |  |  |  |  |
|---|---|--------------------|----|--|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model  |                    |    |  |  |  |  |  |
| Course<br>Outcome                                       | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                    |    |  |  |  |  |  |
| C101.1  | Remember  | Online Quiz        | 20 |  |  |  |  |  |
| C101.2  | Understand  | Class Presentation | 20 |  |  |  |  |  |
| C101.3  | Analyze   | Simulation Program | 20 |  |  |  |  |  |
| C101.4  | Apply   |                    | 20 |  |  |  |  |  |
| C101.5  | Apply   | Assignment         | 20 |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |
| Remember   | 10                      | 10                      | 10                                |  |  |  |  |
| Understand   | 30                      | 30                      | 30                                |  |  |  |  |
| Apply  | 40                      | 40                      | 40                                |  |  |  |  |
| Analyse  | 20                      | 20                      | 20                                |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |                       |                                |                                 |                         |  |
|---|--------------------------------|---------------------------------|-----------------------|--------------------------------|---------------------------------|-------------------------|--|
|   | End                            |                                 |                       |                                |                                 |                         |  |
|   | CA 1 : 100 Ma                  | arks                            | CA 2 : 100 Marks      |                                |                                 | Semester<br>Examination |  |
| SA 1  | FA 1 (4                        | FA 1 (40 Marks)                 |                       | FA 2 (40 Marks)                |                                 | (60%)                   |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | SA 2<br>(60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5           | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|-------------------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C102.1           | 3                 | 1       | 1       | 1       |                   |         |         |         |         |          |          |          |          | 2        |          |
| C102.2           | 3                 | 2       | 2       | 1       |                   |         |         |         |         |          |          |          |          | 2        |          |
| C102.3           | 3                 | 2       | 1       |         |                   |         |         |         |         |          |          | 3        |          | 2        |          |
| C102.4           | 3                 | 3       | 3       | 2       |                   | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| C102.5           | 3                 | 3       | 3       | 2       |                   | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reasonably Agreed |         | greed   | 2       | Moderately Agreed |         |         | ed      | 3       | 9,       | Strongl  | y Agree  | ed       |          |          |

| Nature of Course         M (Practical application)           Pre-requisites         Power Electronics           Course Objectives:         To provide the basic understanding of the dynamic behavior of the power electronic switches.           1         To provide the basic understanding of the dynamic behavior of the power electronic switches.           2         To make the students familiar with the digital processors used in generation of gate pulses for the power electronic switches.           3         To make the students to design gate drive circuits for power converters           5         To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics           Course Outcomes:         Upon completion of the course, students shall have ability to           Upon completion of the course, students and implement the same using simulation tools.         [U]           C103.1         Comprehensive understanding on mathematical modeling of power         [U]           C103.3         Ability of the student to use Ardunio/microcontroller for Power Electronic         [A]           C103.4         Ability of the student to design and simulate various topologies of inverters         [AP]           Ability of the student to design and simulate various topologies of inverters         [AP]           Ability of the student codes of Power MOSFET & IGBT.         C103.1         [A]           2.         Circuit Simulation of Three-phase fully controlle   | 22PE103  | Power Converters Laboratory 0/0/4/2  |  |                   |           |  |  |  |  |  |
|--|--|--|--|-------------------|-----------|--|--|--|--|--|
| Pre-requisites         Power Electronics           Course Objectives:         1         To provide the basic understanding of the dynamic behavior of the power electronic switches.           2         To make the students familiar with the digital processors used in generation of gate pulses for the power electronic switches           3         To make the students acquire knowledge on the design of power electronic circuits and implementing the same using simulation tools           4         To facilitate the students to design gate drive circuits for power converters           5         To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics           Course Outcomes:         Upon completion of the course, students shall have ability to           C103.1         Comprehensive understanding on mathematical modeling of power electronic switches.         [A]           C103.2         Celectronic system and ability to implement the same using simulation tools.         [U]           C103.3         Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum         [AP]           Ability to design and fabricate the gate drive power converter circuits.         [AP]           Ability of the student to design and simulate various topologies of inverters for designing the power supplies         [AP]           C103.4         Situde fibricate the gate drive power converter with R.         [AP]           1.  | Nature of  | Course   | M (Practical application)  |                   |           |  |  |  |  |  |
| Course Objectives:         1       To provide the basic understanding of the dynamic behavior of the power electronic switches.         2       To make the students familiar with the digital processors used in generation of gate pulses for the power electronic switches.         3       To make the students acquire knowledge on the design of power electronic circuits and implementing the same using simulation tools.         4       To facilitate the students to design gate drive circuits for power converters         5       To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics.         Course Outcomes:         Upon completion of the course, students shall have ability to         C103.1       Switches.       [A]         Comprehensive understanding on mathematical modeling of power         C103.3       Switches.       [A]         Ability of the student to use Arduino/microcontroller for Power Electronic         C103.4       Ability of the student to design and sinulate various topologies of inverters in Applications.       [AP]         Ability of the student to design and erive power converter circuits.       [AP]         Ability of design and fabricate the gate drive power converter circuits.         Analyze the three-phase controlled rectifiers and isolated DC-DC converters for designing the power supplies       C103.1       [AP] <td colspa<="" td=""><td>Pre-requi</td><td>sites</td><td>Power Electronics</td><td></td><td></td></td>  | <td>Pre-requi</td> <td>sites</td> <td>Power Electronics</td> <td></td> <td></td> | Pre-requi  | sites  | Power Electronics |           |  |  |  |  |  |
| 1       To provide the basic understanding of the dynamic behavior of the power electronic switches.         2       To make the students familiar with the digital processors used in generation of gate pulses for the power electronic switches         3       To make the students acquire knowledge on the design of power electronic circuits and implementing the same using simulation tools         4       To facilitate the students to design gate drive circuits for power converters         5       To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics         Course Outcomes:         Upon completion of the course, students shall have ability to         Comprehensive understanding on the switching behavior of Power Electronic electronic system and ability to implement the same using simulation tools.         Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools.         Comprehensive understanding on mathematical modeling of power Electronic [A]         Ability of the student to use Arduino/microcontroller for Power Electronic [A]         Comprehensive understanding on the switching behavior of Power Electronic [A]         Course Contents:         Course Contenters         Ability of the student to design and simulate various topologies of inverters for designing the power supplies         Course Contents:  | Course C   | Course Objectives:   |  |                   |           |  |  |  |  |  |
| 2       To make the students familiar with the digital processors used in generation of gate pulses for the power electronic switches         3       To make the students acquire knowledge on the design of power electronic circuits and implementing the same using simulation tools         4       To facilitate the students to design gate drive circuits for power converters         5       To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics         Course Outcomes:         Upon completion of the course, students shall have ability to         Comprehensive understanding on mathematical modeling of power         C103.1       Comprehensive understanding on mathematical modeling of power electronic applications.       [A]         C103.2       electronic system and ability to implement the same using simulation tools.       [U]         C103.3       applications.       [A]         C103.4       Ability of the student to design and simulate various topologies of inverters (AP)       [AP]         Ability to design and fabricate the gate drive power converter circuits.       [AP]         Analyze the three-phase controlled rectifiers and isolated DC-DC converters       [AP]         1       Study of switching characteristics of Power MOSFET & IGBT.       C103.1       [A]         2.       Circuit Simulation of Three-phase Voltage Source Inverter with R.       [A]       [A]       [   | 1  | 1 To provide the basic understanding of the dynamic behavior of the power electronic switches.   |  |                   |           |  |  |  |  |  |
| 3       To make the students acquire knowledge on the design of power electronic circuits and implementing the same using simulation tools         4       To facilitate the students to design gate drive circuits for power converters         5       To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics         Course Outcomes:         Upon completion of the course, students shall have ability to         C103.1       Comprehensive understanding on the switching behavior of Power Electronic [A]         C013.2       Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools.       [U]         C103.3       Applications.       [A]         C103.4       Ability of the student to use Arduino/microcontroller for Power Electronic applications.       [AP]         C103.4       Ability of the student to design and simulate various topologies of inverters for designing the power supplies       [AP]         Course Contents:       SNo       List of Experiments       C0<br>Mapping       RBT         1       Study of switching characteristics of Power MOSFET & IGBT.       C103.2       [A]         2.       Circuit Simulation of Three-phase fully controlled converter with R, RL&       C103.2       [A]         3.       Circuit Simulation of Three-phase PWM inverter and study of spectrum analysis for various modulation indicles.       C103.   | 2  | To make the students familiar with the digital processors used in generation of gate pulses for the power electronic switches              |  |                   |           |  |  |  |  |  |
| 4       To facilitate the students to design gate drive circuits for power converters         5       To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics         Course Outcomes:         Upon completion of the course, students shall have ability to         C103.1       Comprehensive understanding on the switching behavior of Power Electronic [A]         C103.2       Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools.       [U]         C103.3       Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum       [AP]         Ability of the student to design and fabricate the gate drive power converter circuits.       Analyze the three-phase controlled rectifiers and isolated DC-DC converters for designing the power supplies       [AP]         Course Contents:       S.No       List of Experiments       CO Mapping RBT         1       Study of switching characteristics of Power MOSFET & IGBT.       C103.2       [A]         2.       Circuit Simulation of Three-phase semi-converter with R, RL&       C103.2       [A]         3.       Circuit Simulation of Three-phase Voltage Source Inverter in 180       C103.3       [U]         4.       Circuit Simulation of Three-phase Z-source inverter with R load.       C103.4       [AP]         5.       Simula  | 3  | To make the implementing   | students acquire knowledge on the design of power e g the same using simulation tools  | lectronic cir     | cuits and |  |  |  |  |  |
| Solution         Convertion         Convertion         Convertion           Course Outcomes:         Upon completion of the course, students shall have ability to         [A]           C103.1         Comprehensive understanding on the switching behavior of Power Electronic         [A]           C103.2         Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools.         [U]           C103.3         Ability of the student to use Arduino/microcontroller for Power Electronic applications.         [A]           C103.4         Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum         [AP]           Ability to design and fabricate the gate drive power converter circuits.         Analyze the three-phase controlled rectifiers and isolated DC-DC converters for designing the power supplies         [AP]           Course Contents:         Corcuit Simulation of Three-phase semi-converter with R, RL& C103.1         [A]           3.         Circuit Simulation of Three-phase fully controlled converter with C103.2         [U]           4.         Circuit Simulation of Three-phase Voltage Source Inverter with R load.         C103.3         [U]           5.         Circuit Simulation of Three-phase Z-source inverter with R load.         C103.3         [U]           6.         Simulation of Three-phase Z-source inverter with R load.         C10   | 4  | To facilitate  | the students to design gate drive circuits for power con   | verters           |           |  |  |  |  |  |
| Course Outcomes:         Upon completion of the course, students shall have ability to         C103.1       Comprehensive understanding on the switching behavior of Power Electronic       [A]         C103.2       Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools.       [U]         C103.3       Ability of the student to use Arduino/microcontroller for Power Electronic applications.       [A]         C103.4       Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum       [AP]         Ability to design and fabricate the gate drive power converter circuits. Analyze the three-phase controlled rectifiers and isolated DC-DC converters for designing the power supplies       [AP]         Course Contents:       Constant Simulation of Three-phase semi-converter with R, RL& C103.1       [A]         2.       RLE load.       Clicuit Simulation of Three-phase fully controlled converter with R, RL& C103.2       [U]         4.       Circuit Simulation of Three-phase VUM inverter and study of spectrum analysis for various modulation indices.       C103.3       [U]         5.       Circuit Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of a single-phase AZ-source inverter with R load.       C103.4       [AP]         6.       Simulation of a single-p  | 5  | To provide the harmonics   | ne fundamentals of DC-AC power converter topologies  | and analyz        | e the     |  |  |  |  |  |
| Upon completion of the course, students shall have ability to           C103.1         Comprehensive understanding on the switching behavior of Power Electronic         [A]           C103.2         Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools.         [U]           C103.3         Ability of the student to use Arduino/microcontroller for Power Electronic applications.         [A]           C103.4         Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum         [AP]           C103.5         Ability of edsign and fabricate the gate drive power converter circuits. Analyze the three-phase controlled rectifiers and isolated DC-DC converters for designing the power supplies         [AP]           Corcut Simulation of Three-phase femi-converter with R, RL&         C103.1         [A]           2.         Circuit Simulation of Three-phase fully controlled converter with R, RL&         C103.2         [U]           3.         R, RL & RLE load.         C103.3         [U]         [U]           4.         Circuit Simulation of Three-phase Voltage Source Inverter in 180 and 120 degree mode of conduction.         C103.3         [U]           5.         Circuit Simulation of a five-level cascaded multilevel inverter with R load.         C103.4         [AP]           7.         Simulation of a single-phase Z-source inverter with R   | Course C   | utcomes:   |  |                   |           |  |  |  |  |  |
| C103.1         Comprehensive understanding on the switching behavior of Power Electronic<br>Switches.         [A]           C103.2         Comprehensive understanding on mathematical modeling of power<br>electronic system and ability to implement the same using simulation tools.         [U]           C103.3         Ability of the student to use Arduino/microcontroller for Power Electronic<br>applications.         [A]           C103.4         Ability of the student to design and simulate various topologies of inverters<br>and analyze their harmonic spectrum         [AP]           C103.5         Analyze the three-phase controlled rectifiers and isolated DC-DC converters<br>for designing the power supplies         [AP]           Course Contents:         Concurse Study of Switching characteristics of Power MOSFET & IGBT.         C103.1         [A]           2.         Circuit Simulation of Three-phase semi-converter with R, RL&<br>RLE load.         C103.2         [A]           3.         Circuit Simulation of Three-phase fully controlled converter with<br>R, RL & RLE load.         C103.3         [U]           4.         Circuit Simulation of Three-phase Voltage Source Inverter in 180<br>and 120 degree mode of conduction.         C103.3         [U]           5.         Simulation of Three-phase PWM inverter and study of<br>spectrum analysis for various modulation indices.         C103.3         [U]           6.         Simulation of a single-phase Z-source inverter with R load.         C103.4         [AP] <td>Upon cor</td> <td>npletion of th</td> <td>e course, students shall have ability to</td> <td></td> <td></td>  | Upon cor   | npletion of th   | e course, students shall have ability to   |                   |           |  |  |  |  |  |
| C103.2         Comprehensive understanding on mathematical modeling of power<br>electronic system and ability to implement the same using simulation tools.         [U]           C103.3         Ability of the student to use Arduino/microcontroller for Power Electronic<br>applications.         [A]           C103.4         Ability of the student to design and simulate various topologies of inverters<br>and analyze their harmonic spectrum         [AP]           C103.5         Ability to design and fabricate the gate drive power converter circuits.<br>Analyze the three-phase controlled rectifiers and isolated DC-DC converters<br>for designing the power supplies         [AP]           Course Contents:         CO<br>Mapping         RBT           1.         Study of switching characteristics of Power MOSFET & IGBT.<br>Circuit Simulation of Three-phase semi-converter with R, RL&<br>RLE load.         C103.2         [A]           3.         Circuit Simulation of Three-phase Voltage Source Inverter in 180<br>and 120 degree mode of conduction.         C103.3         [U]           4.         Circuit Simulation of Three-phase PWM inverter and study of<br>spectrum analysis for various modulation indices.         C103.4         [AP]           5.         Simulation of a single-phase Z-source inverter with R load.         C103.4         [AP]           6.         Simulation of a single-phase Z-source inverter with R load.         C103.4         [AP]           9.         Simulation of a five-level cascaded multilevel inverter with R load. <t< td=""><td>C103.1</td><td>Comprehens<br/>Switches.</td><td>sive understanding on the switching behavior of Power</td><td>Electronic</td><td>[A]</td></t<> | C103.1   | Comprehens<br>Switches.  | sive understanding on the switching behavior of Power  | Electronic        | [A]       |  |  |  |  |  |
| Ability of the student to use Arduino/microcontroller for Power Electronic applications.       [A]         C103.3       Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum       [AP]         C103.4       and analyze their harmonic spectrum       [AP]         Ability to design and fabricate the gate drive power converter circuits. Analyze the three-phase controlled rectifiers and isolated DC-DC converters for designing the power supplies       [AP]         Course Contents:       CO       MBT         1.       Study of switching characteristics of Power MOSFET & IGBT.       C103.1       [A]         2.       Circuit Simulation of Three-phase semi-converter with R, RL&       C103.2       [U]         3.       Circuit Simulation of Three-phase Voltage Source Inverter in 180       C103.3       [U]         4.       and 120 degree mode of conduction.       C103.3       [U]         5.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of three-phase AC voltage Controller/PIC       [I]       [I]         8.       Simulation of Three-phase Z-source inverter with R load.       C103.4       [AP]         9.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [AP]         9.       Simulation of Four quadrant   | C103.2   | Comprehens<br>electronic sy  | sive understanding on mathematical modeling of power<br>stem and ability to implement the same using simulation                          | on tools.         | [U]       |  |  |  |  |  |
| Ability of the student to design and simulate various topologies of inverters<br>and analyze their harmonic spectrum       [AP]         C103.4       Ability to design and fabricate the gate drive power converter circuits.<br>Analyze the three-phase controlled rectifiers and isolated DC-DC converters<br>for designing the power supplies       [AP]         C103.5       Course Contents:       [AP]         Course Contents:       CO<br>Mapping       RBT         1.       Study of switching characteristics of Power MOSFET & IGBT.       C103.1       [A]         2.       Circuit Simulation of Three-phase semi-converter with R, RL&<br>RLE load.       C103.2       [A]         3.       Circuit Simulation of Three-phase fully controlled converter with<br>R, RL & RLE load.       C103.3       [U]         4.       Circuit Simulation of Three-phase Voltage Source Inverter in 180<br>and 120 degree mode of conduction.       C103.3       [U]         5.       Circuit simulation of Three-phase PWM inverter and study of<br>spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of Five-ephase AC voltage Controller with R load.       C103.4       [AP]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of a alting pulse using Ar  | C103.3   | Ability of the applications.   | student to use Arduino/microcontroller for Power Elect   | ronic             | [A]       |  |  |  |  |  |
| Ability to design and fabricate the gate drive power converter circuits.<br>Analyze the three-phase controlled rectifiers and isolated DC-DC converters<br>for designing the power supplies       [AP]         Course Contents:       Image: Converter supplies       CO<br>Mapping       RBT         1.       Study of switching characteristics of Power MOSFET & IGBT.       C103.1       [A]         2.       Circuit Simulation of Three-phase semi-converter with R, RL&<br>RLE load.       C103.2       [[A]         3.       R, RL & RLE load.       C103.2       [[U]         4.       Circuit Simulation of Three-phase fully controlled converter with<br>R, RL & RLE load.       C103.3       [U]         5.       Circuit Simulation of Three-phase Voltage Source Inverter in 180<br>and 120 degree mode of conduction.       C103.3       [U]         5.       Circuit Simulation of Three-phase PWM inverter and study of<br>spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [R]         9.       Simulation of three-phase AC voltage Controller with R load.       C103.4       [A]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC<br>microcontroller for a DC-DC converter and single-phase voltage<br>source inverter.       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]  | C103.4   | Ability of the student to design and simulate various topologies of inverters [AP]   |  |                   |           |  |  |  |  |  |
| Course Contents:       Compaping       RBT         S.No       List of Experiments       COMapping       RBT         1.       Study of switching characteristics of Power MOSFET & IGBT.       C103.1       [A]         2.       Circuit Simulation of Three-phase semi-converter with R, RL&       C103.2       [A]         3.       Circuit Simulation of Three-phase fully controlled converter with R, RL & RLE load.       C103.2       [U]         4.       Circuit Simulation of Three-phase Voltage Source Inverter in 180 and 120 degree mode of conduction.       C103.3       [U]         5.       Circuit simulation of Three-phase PWM inverter and study of spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of three-phase AC voltage Controller with R load.       C103.4       [AP]         9.       Simulation of three-phase AC voltage Controller with R load.       C103.5       [U]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC microcontroller for a DC-DC converter and single-phase voltage source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103   | C103.5   | Ability to des<br>Analyze the<br>for designing   | sign and fabricate the gate drive power converter circui<br>three-phase controlled rectifiers and isolated DC-DC c<br>the power supplies | ts.<br>onverters  | [AP]      |  |  |  |  |  |
| S.No         List of Experiments         CO<br>Mapping         RBT           1.         Study of switching characteristics of Power MOSFET & IGBT.         C103.1         [A]           2.         Circuit Simulation of Three-phase semi-converter with R, RL&<br>RLE load.         C103.2         [A]           3.         Circuit Simulation of Three-phase fully controlled converter with<br>R, RL & RLE load.         C103.2         [U]           4.         Circuit Simulation of Three-phase Voltage Source Inverter in 180<br>and 120 degree mode of conduction.         C103.3         [U]           5.         Circuit simulation of Three-phase PWM inverter and study of<br>spectrum analysis for various modulation indices.         C103.3         [U]           6.         Simulation of a single-phase Z-source inverter with R load.         C103.4         [AP]           7.         Simulation of a five-level cascaded multilevel inverter with R load.         C103.4         [R]           8.         Simulation of Four quadrant operation of DC Chopper.         C103.5         [U]           9.         Simulation of a Cloug pulse using Arduino/Micro Controller/PIC<br>microcontroller for a DC-DC converter and single-phase voltage<br>source inverter.         C103.5         [A]           11.         Simulation of a Flyback DC-DC converter         C103.5         [A]           30         Total Hours         30  | Course C   | ontents:   |  |                   |           |  |  |  |  |  |
| 1.       Study of switching characteristics of Power MOSFET & IGBT.       C103.1       [A]         2.       Circuit Simulation of Three-phase semi-converter with R, RL&       C103.2       [A]         3.       Circuit Simulation of Three-phase fully controlled converter with R, RL& RLE load.       C103.2       [U]         4.       Circuit Simulation of Three-phase Voltage Source Inverter in 180 and 120 degree mode of conduction.       C103.3       [U]         5.       Circuit simulation of Three-phase PWM inverter and study of spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [AP]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC microcontroller for a DC-DC converter and single-phase voltage source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours         30  | S.No   |  | List of Experiments  | CO<br>Mapping     | RBT       |  |  |  |  |  |
| 2.       Circuit Simulation of Three-phase semi-converter with R, RL&       C103.2       [A]         3.       Circuit Simulation of Three-phase fully controlled converter with R, RL & RLE load.       C103.2       [U]         4.       Circuit Simulation of Three-phase Voltage Source Inverter in 180 and 120 degree mode of conduction.       C103.3       [U]         5.       Circuit simulation of Three-phase PWM inverter and study of spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [AP]         8.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         9.       Simulation of Gating pulse using Arduino/Micro Controller/PIC microcontroller for a DC-DC converter and single-phase voltage source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours 30         Xot Med Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters, And and Design".         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters, And and Design".       Anti-Addition   | 1.   | Study of swit  | tching characteristics of Power MOSFET & IGBT.   | C103.1            | [A]       |  |  |  |  |  |
| 3.       Circuit Simulation of Three-phase fully controlled converter with R, RL & RLE load.       C103.2       [U]         4.       Circuit Simulation of Three-phase Voltage Source Inverter in 180 and 120 degree mode of conduction.       C103.3       [U]         5.       Circuit simulation of Three-phase PWM inverter and study of spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [R]         8.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC microcontroller for a DC-DC converter and single-phase voltage source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours 30         Automation & William P. Robbins, "Power Electronics-Converters, Automation & Automation & Automation & Converters, Automation & C103.5         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters, Automation & Converters, Converters, Converters, Converters, Converters, Converters, Converters, Converters, Converters, Con  | 2.   | Circuit Simul<br>RLE load.   | lation of Three-phase semi-converter with R, RL&   | C103.2            | [A]       |  |  |  |  |  |
| 4.       Circuit Simulation of Three-phase Voltage Source Inverter in 180<br>and 120 degree mode of conduction.       C103.3       [U]         5.       Circuit simulation of Three-phase PWM inverter and study of<br>spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [R]         8.       Simulation of three-phase AC voltage Controller with R load.       C103.4       [AP]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC<br>microcontroller for a DC-DC converter and single-phase voltage<br>source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours         30         Text Books:  | 3.   | Circuit Simu<br>R, RL & RLE  | lation of Three-phase fully controlled converter with load.  | C103.2            | [U]       |  |  |  |  |  |
| 5.       Circuit simulation of Three-phase PWM inverter and study of spectrum analysis for various modulation indices.       C103.3       [U]         6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [R]         8.       Simulation of three-phase AC voltage Controller with R load.       C103.4       [AP]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC       C103.5       [A]         10.       Generation of a Flyback DC-DC converter and single-phase voltage       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours         30         Text Books:         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters, Applications and Designs" John William P. Robbins, "Power Electronics-Converters, Applications and Designs" John William P. Robbins, "Power Electronics-Converters, Applications and Designs" John William P. Robbins, "Power Electronics-Converters, Applications and Designs" John William P. Robbins, "Power Electronics-Converters, Applications and Designs" John William P. Robbins, "Power Electronics-Converters, Applications and Designs" John William P. Robbins, "Power Electronics-Converters, App   | 4.   | Circuit Simuland 120 deg   | lation of Three-phase Voltage Source Inverter in 180 ree mode of conduction.   | C103.3            | [U]       |  |  |  |  |  |
| 6.       Simulation of a single-phase Z-source inverter with R load.       C103.4       [AP]         7.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [R]         8.       Simulation of three-phase AC voltage Controller with R load.       C103.4       [AP]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         9.       Simulation of Gating pulse using Arduino/Micro Controller/PIC       Image: C103.5       [A]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC       Image: C103.5       [A]         11.       Simulation of a Flyback DC-DC converter and single-phase voltage       C103.5       [A]         Total Hours         30         Text Books:         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters, Applications and Design", John William 2, Open edition, 2014   | 5.   | Circuit simul spectrum an  | ation of Three-phase PWM inverter and study of alysis for various modulation indices.  | C103.3            | [U]       |  |  |  |  |  |
| 7.       Simulation of a five-level cascaded multilevel inverter with R load.       C103.4       [R]         8.       Simulation of three-phase AC voltage Controller with R load.       C103.4       [AP]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC       C103.5       [A]         10.       microcontroller for a DC-DC converter and single-phase voltage source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours 30         Text Books:         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters, Applications and Design", Jahr William P. Opene adjition 2014   | 6.   | Simulation o   | f a single-phase Z-source inverter with R load.  | C103.4            | [AP]      |  |  |  |  |  |
| 8.       Simulation of three-phase AC voltage Controller with R load.       C103.4       [AP]         9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC       C103.5       [A]         10.       Microcontroller for a DC-DC converter and single-phase voltage       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours         30         Text Books:         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters,   | 7.   | Simulation o   | f a five-level cascaded multilevel inverter with R load.   | C103.4            | [R]       |  |  |  |  |  |
| 9.       Simulation of Four quadrant operation of DC Chopper.       C103.5       [U]         10.       Generation of Gating pulse using Arduino/Micro Controller/PIC       C103.5       [A]         10.       microcontroller for a DC-DC converter and single-phase voltage       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours         Text Books:         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters,         1       Applications and Design", John Wiley 2 Open edition 2014   | 8.   | Simulation o   | f three-phase AC voltage Controller with R load.   | C103.4            | [AP]      |  |  |  |  |  |
| 10.       Generation of Gating pulse using Arduino/Micro Controller/PIC<br>microcontroller for a DC-DC converter and single-phase voltage<br>source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours         30         Text Books:         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters,         1       Applications and Design", John Wiley 2, Open advice, 2014  | 9.   | Simulation o   | f Four quadrant operation of DC Chopper.   | C103.5            | [U]       |  |  |  |  |  |
| Source inverter.       C103.5       [A]         11.       Simulation of a Flyback DC-DC converter       C103.5       [A]         Total Hours 30         Text Books:         Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters,         1       Applications and Design", John William P. Robbins, "2014  | 10.  | Generation of Gating pulse using Arduino/Micro Controller/PIC<br>microcontroller for a DC-DC converter and single-phase voltage C103.5 [A] |  |                   |           |  |  |  |  |  |
| Total Hours     30       Text Books:     1       1     Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters,  | 11.  | Simulation of a Flyback DC-DC converter  |  |                   |           |  |  |  |  |  |
| Text Books:         1       Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters,         1       Applications and Desire", John William P. Robbins, "Over a division Converters,   |  |  | Total Hours  | 3(                | )         |  |  |  |  |  |
| 1 Ned Mohan, Tore M. Undeland & William P. Robbins, "Power Electronics-Converters,   | Text Boo   | ks:  |  |                   |           |  |  |  |  |  |
| Applications and Design, John Wiley & Sons edition 2011.   | 1  | Ned Mohan,<br>Applications   | Tore M. Undeland & William P. Robbins, "Power Elect<br>and Design", John Wiley & Sons edition 2011.                                      | ronics-Conv       | verters,  |  |  |  |  |  |

| 2        | M.D.Singh, "Power Electronics", Tata McGraw-Hill, 2 <sup>nd</sup> edition 2014    |
|----------|---|
| 3        | P.S. Bhimbra, "Power Electronics", Khanna Publishers edition 2018.                |
| Referenc | e Books:  |
| 1        | Vedam Subramanian, "Power Electronics" New age international Second edition 2018. |
| 2        | P.C. Sen, "Modern Power Electronics", Tata McGraw-Hill, edition 2018.             |
| 3        | Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson, 2015            |
| Web Refe | erences:  |
| 1        | https://nptel.ac.in/courses/108101038/  |
| 2        | https://www.tutorialspoint.com/power_electronics/index.htm                        |
|          | https://in.mathworks.com/videos/developing-dc-dc-converter-control-with-          |
| 3        | simulinkautomatically-generating-controller-code-for-implementation-on-embedded-  |
|          | processor1535540362783.html   |
| 1        | https://in.mathworks.com/videos/series/developing-dc-dc-converter-control-        |
| 4        | withsimulink.html   |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total Continuous<br>Assessment | End Semester<br>Continuous<br>Examination<br>Esessment |     |  |
|-------------------------|-------------------------|-------|--------------------------------|--|-----|--|
| 75                      | 25                      | 100   | 60                             | 40   | 100 |  |

| Assessment based on Continuous and End Semester Examination |                         |                                       |                      |  |  |  |  |  |
|---|-------------------------|---------------------------------------|----------------------|--|--|--|--|--|
|   | Continuous As<br>[100 l | End Semester<br>Practical Examination |                      |  |  |  |  |  |
| Bloom's Level   | FA<br>(75 Marks)        | SA<br>(25 Marks)                      | (40%)<br>[100 Marks] |  |  |  |  |  |
| Remember  | -                       | -                                     | -                    |  |  |  |  |  |
| Understand  | 20                      | 20                                    | 20                   |  |  |  |  |  |
| Apply   | 30                      | 30                                    | 30                   |  |  |  |  |  |
| Analyse   | 30                      | 30                                    | 30                   |  |  |  |  |  |
| Evaluate  | -                       | -                                     | -                    |  |  |  |  |  |
| Create  | 20                      | 20                                    | 20                   |  |  |  |  |  |

| No. of<br>the CO | РО<br>1 | PO<br>2 | PO<br>3 | РО<br>4 | PO<br>5 | PO<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C103.1           | 3       | 3       | 2       | 2       |         |         | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C103.2           | 3       | 2       | 1       | 1       |         |         | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C103.3           | 3       | 3       | 2       | 2       | 3       |         | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C103.4           | 3       | 2       | 1       | 1       |         |         | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C103.5           | 3       | 2       | 1       | 1       |         |         | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| 1                | Reas    | sonab   | oly Ag  | greed   | 2       | N       | loder   | ately   | Agre    | ed       | 3        | 0,       | Strongl  | y Agree  | ed       |

| Nature of Course         G (Theory)           Course Pre requisites         Electrical Machines, Power Electronics           Course Objectives:         Introduce basic concepts of load and drive interaction.           1         To introduce basic concepts of load and drive interaction.           2         methods.           3         To introduce design methodology and to provide knowledge on industrial drive applications           Course Outcomes:         Upon completion of the course, students shall have ability to           C201.1         Interpret concepts of load and different speed control methods of DC drives.         [A]           C201.2         Analyze the operation chopper fed DC drives.         [A]           C201.4         Examine the different speed control concepts of AC drives.         [A]           C201.5         Apply the digital drive control concepts on industrial drives.         [A]           Caurse Contents:         Module 1: Basic Drive system and DC motor Control         15 Hrs           Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power shalt bree phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed Drives, input filter design. Braking and speed control, soft stating of induction motor speed control. Solid state controllers for Stator voltage control, soft stating of induction motors, Rotor side speed control drove induction motor induction motor drives.   | 22PE201  |   | Electric Drives System  | 3/0/0/3   |  |  |  |  |  |  |
|---|--|---|---|---|--|--|--|--|--|--|
| Course Pre requisites         Electrical Machines, Power Electronics           Course Objectives:         To introduce basic concepts of load and drive interaction.           1         To introduce basic concepts of load and drive interaction.           2         To introduce design methodology and to provide knowledge on industrial drive applications           Course Outcomes:         Upon completion of the course, students shall have ability to           C201.1         Interpret concepts of load and different speed control methods of DC drives.         [U]           C201.2         Analyze the operation chopper fed DC drives.         [A]           C201.3         Infer the operation of induction motor and synchronous motor drives.         [U]           C201.4         Examine the different speed control concepts of AC drives.         [A]           C201.5         Apply the digital drive control concepts on industrial drives.         [A]           C201.4         Examine the different speed control concepts of loads, shaft-load coupling systems. Stability of power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive. Input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.           Module 2: Induction Motor Control         15 Hrs           Conventional methods of induction motors, Rotor si  | Nature o   | of Course   | G (Theory)  |   |  |  |  |  |  |  |
| Course Objectives:           1         To introduce basic concepts of load and drive interaction.           2         To gain knowledge on speed control concepts of AC, DC drives and its braking methods.           3         applications           Course Outcomes:         Upon completion of the course, students shall have ability to           C201.1         Interpret concepts of load and different speed control methods of DC drives.         [U]           C201.2         Analyze the operation chopper fed DC drives.         [A]           C201.4         Infer the operation of induction motor and synchronous motor drives.         [J]           C201.5         Apply the digital drive control concepts of AC drives.         [A]           C201.4         Examine the different speed control concepts of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, shalliny of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.           Module 2: Induction Motor Control         15 Hrs           Conventional methods of induction motor speed control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction dotesing aspects of machines. Industrial Drives-Digital control of Electric Drives and there/phicatino.   | Course   | Pre requisites  | Electrical Machines, Power Electronics  |   |  |  |  |  |  |  |
| 1       To introduce basic concepts of load and drive interaction.         2       To gain knowledge on speed control concepts of AC, DC drives and its braking methods.         3       To introduce design methodology and to provide knowledge on industrial drive applications         Course Outcomes:         Upon completion of the course, students shall have ability to         C201.1       Interpret concepts of load and different speed control methods of DC [U]         C201.2       Analyze the operation chopper fed DC drives.       [A]         C201.3       Infer the operation of induction motor and synchronous motor drives.       [U]         C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.6       Examine the different speed control concepts of AC drives.       [A]         C201.7       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         Course Contents:       Module 1: Basic Drive system and DC motor Control       15 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-bad coupling systems. Stability of power electronic drive. Numer factor improvement techniques, four quadran operation. Chopper fed D.C motor drive. Braking and speed reversa   | Course Objectives:   |   |   |   |  |  |  |  |  |  |
| 2       To gain knowledge on speed control concepts of AC, DC drives and its braking methods.         3       To introduce design methodology and to provide knowledge on industrial drive applications         Course Outcomes:         Upon completion of the course, students shall have ability to         C201.1       Interpret concepts of load and different speed control methods of DC drives.       [U]         C201.2       Analyze the operation chopper fed DC drives.       [A]         C201.3       Infer the operation of induction motor and synchronous motor drives.       [U]         C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [AP]         Course Contents:       Module 1: Basic Drive system and DC motor Control       15 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase converter fed D.C motor drives.       15 Hrs         Control drive suising choppers, multiphase choppers. PV fed DC drives.       Module 2: Induction Motor Control       15 Hrs         Control, soft starting of induction motors, Rotor side speed control of wound rotor induction motors. Store side control is provernet techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed control, soft starting of induction mot  | 1  | 1 To introduce basic concepts of load and drive interaction.  |   |   |  |  |  |  |  |  |
| 3       To introduce design methodology and to provide knowledge on industrial drive applications         Course Outcomes:       Upon completion of the course, students shall have ability to         C201.1       Interpret concepts of load and different speed control methods of DC drives.       [U]         C201.2       Analyze the operation chopper fed DC drives.       [A]         C201.3       Infer the operation of induction motor and synchronous motor drives.       [U]         C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [AP]         Course Contents:       Module 1: Basic Drive system and DC motor Control       15 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase convert fed DC. motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.         Module 2: Induction Motor Control       15 Hrs         Control methods of induction motors, Rotor side speed control wound rotor induction motors. Slip power recovery scheme. Voltage source and Current source inverter fed induction motor sche speed control of wound rotor induction motor sche speed control, load computated inverter drives, switched reluctance motors and permanent magnet motor driv  | 2  | 2 To gain knowledge on speed control concepts of AC, DC drives and its braking methods.                   |   |   |  |  |  |  |  |  |
| Course Outcomes:         Upon completion of the course, students shall have ability to         C201.1       Interpret concepts of load and different speed control methods of DC drives.       [U]         C201.2       Analyze the operation chopper fed DC drives.       [A]         C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.6       Apply the digital drive control concepts on industrial drives.       [A]         C201.7       Apply the digital drive control concepts on industrial drives.       [A]         C201.8       Examine the different speed control concepts of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed control of Motor Control       15 Hrs         Conventional methods of induction motor speed control. Solid state controllers for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motor rives-d-q axis modeling and vector control.       15 Hrs         Module 2: Induction Motor Control       15 Hrs       15 Hrs         Conventional methods of induction motors, Rotor side speed control of wound rotor induction motor rives-d-q axis modeling and vector control.       15 Hrs   | 3  | To introduce d applications   | esign methodology and to provide knowledge on industrial driv   | /e  |  |  |  |  |  |  |
| C201.1       Interpret concepts of load and different speed control methods of DC drives.       [U]         C201.2       Analyze the operation chopper fed DC drives.       [A]         C201.3       Infer the operation of induction motor and synchronous motor drives.       [U]         C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         Course Contents:  | Course (<br>Upon co  | Outcomes:<br>ompletion of the   | e course, students shall have ability to  |   |  |  |  |  |  |  |
| C201.2       Analyze the operation chopper fed DC drives.       [A]         C201.3       Infer the operation of induction motor and synchronous motor drives.       [U]         C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [A]         Cater controls       15 Hrs       Stater control of prove relectronic drive. Conventional methods of DC motor represent techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.       15 Hrs         Module 2:       Induction motors, Rotor side speed control of wound rotor induction motor drives. Slip power recovery scheme. Volta   | C201.1   | Interpret conc<br>drives.   | cepts of load and different speed control methods of DC   | [U]   |  |  |  |  |  |  |
| C201.3       Infer the operation of induction motor and synchronous motor drives.       [U]         C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [AP]         Course Contents:       IAPI         Module 1: Basic Drive system and DC motor Control       15 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.         Module 2: Induction Motor Control       15 Hrs         Conventional methods of induction motor speed control. Solid state controllers for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motor shoed control.       15 Hrs         Module 3: Synchronous Motor Control       15 Hrs         Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines. Industrial Drives-Digital control of Electric Drives and their Application.       45         Text Books:       1       G. K. Dubey," Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.       2011  | C201.2   | Analyze the op  | peration chopper fed DC drives.   | [A]   |  |  |  |  |  |  |
| C201.4       Examine the different speed control concepts of AC drives.       [A]         C201.5       Apply the digital drive control concepts on industrial drives.       [AP]         Course Contents:       [AP]         Module 1: Basic Drive system and DC motor Control       15 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.         Module 2: Induction Motor Control       15 Hrs         Conventional methods of induction motors, Rotor side speed control of wound rotor induction motors. Slip power recovery scheme. Voltage source and Current source inverter fed induction motor speed control.         Module 3: Synchronous Motor Control       15 Hrs         Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines. Industrial Drives-Digital control of Electric Drives and their Application.         1       G. K. Dubey," Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.       2011.         2       R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010       3 Bimal K.Bose, 'Modern Power E   | C201.3   | Infer the opera   | ation of induction motor and synchronous motor drives.  | [U]   |  |  |  |  |  |  |
| C201.5       Apply the digital drive control concepts on industrial drives.       [AP]         Course Contents:       I5 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.         Module 2: Induction Motor Control       15 Hrs         Conventional methods of induction motors speed control. Solid state controlles for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motor drives. Jup over recovery scheme. Voltage source and Current source inverter fed induction motor drives. Super control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines. Industrial Drives-Digital control of Electric Drives and their Application.       45         Text Books:       1       G. K. Dubey," Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.       2         2       R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010       3         3       Bimal K. Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd., New Delhi, 2014.       2         Reference Books:       1       Ve                       | C201.4   | Examine the c   | lifferent speed control concepts of AC drives.  | [A]   |  |  |  |  |  |  |
| Course Contents:       15 Hrs         Module 1: Basic Drive system and DC motor Control       15 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive. Conventional methods of DC motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.         Module 2: Induction Motor Control       15 Hrs         Conventional methods of induction motor speed control. Solid state controllers for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motors. Slip power recovery scheme. Voltage source and Current source inverter fed induction motor drives-d-q axis modeling and vector control.         Module 3: Synchronous Motor Control       15 Hrs         Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines. Industrial Drives-Digital control of Electric Drives and their Application.       45         Text Books:       1       G. K. Dubey," Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.       2         2       R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010       3       Bimal K. Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd., New Delhi, 2014.       < | C201.5   | Apply the digit   | al drive control concepts on industrial drives.   | [AP]  |  |  |  |  |  |  |
| Module 1: Basic Drive system and DC motor Control       15 Hrs         Basic power electronic drive system, components. Different types of loads, shaft-load coupling       systems. Stability of power electronic drive. Conventional methods of DC motor speed control,         single phase and three phase converter fed D.C motor drive. Power factor improvement       techniques, four quadrant operation. Chopper fed drives, input filter design. Braking and speed         reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.       15 Hrs         Module 2: Induction Motor Control       15 Hrs         Conventional methods of induction motor speed control. Solid state controllers for Stator voltage       control, soft starting of induction motors, Rotor side speed control of wound rotor induction         motors. Slip power recovery scheme. Voltage source and Current source inverter fed induction       15 Hrs         Speed control of synchronous Motor Control       15 Hrs         Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines. Industrial Drives-Digital control of Electric Drives Narosa Publishing House", 2nd edition, 2011.         2       R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010         3       Bimal K. Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd., New Delhi, 2014.         Reference Books:       1   | Course   | Contents:   | •   |   |  |  |  |  |  |  |
| Module 3: Synchronous Motor Control       15 Hrs         Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines. Industrial Drives-Digital control of Electric Drives and their Application.       45         Text Books:         1       G. K. Dubey, "Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.         2       R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010         3       Bimal K. Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd., New Delhi, 2014.         Reference Books:         1       VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2009         2       P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007   | reversal<br>Module 2<br>Conventi<br>control, s<br>motors. S  | of DC motor driv<br><b>2: Induction Mc</b><br>ional methods of<br>soft starting of in<br>Slip power recov | ves using choppers, multiphase choppers. PV fed DC drives.<br><b>otor Control</b><br>f induction motor speed control. Solid state controllers for Stat<br>duction motors, Rotor side speed control of wound rotor induc<br>very scheme. Voltage source and Current source inverter fed in<br>odeling and vector control | <b>15 Hrs</b><br>or voltage<br>tion<br>nduction |  |  |  |  |  |  |
| Text Books:1G. K. Dubey," Fundamentals of electric Drives, Narosa Publishing House", 2nd edition,<br>2011.2R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of<br>India Pvt. Ltd., New Delhi, 2010India Pvt. Ltd., New Delhi, 20103Bimal K .Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd.,<br>New Delhi, 2014.VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-<br>Hill publishing company Ltd., New Delhi, 20092P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007  | Module Speed co<br>switched<br>of machin   | <b>3: Synchronou</b><br>ontrol of synchro<br>reluctance moto<br>nes. Industrial D                         | <b>s Motor Control</b><br>onous motors, field oriented control, load commutated invert<br>ors and permanent magnet motor drives. Introduction to desig<br>rives-Digital control of Electric Drives and their Application.   | <b>15 Hrs</b><br>er drives,<br>n aspects        |  |  |  |  |  |  |
| Text Books:         1       G. K. Dubey, "Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.         2       R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010         3       Bimal K .Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd., New Delhi, 2014.         Reference Books:         1       VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2009         2       P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007   |  |   | Total Hours   | 45  |  |  |  |  |  |  |
| 1       G. K. Dubey, "Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.         2       R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010         3       Bimal K .Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd., New Delhi, 2014.         Reference Books:         1       VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2009         2       P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007   | Text Boo   | oks:  |   |   |  |  |  |  |  |  |
| <ul> <li>R. Krishnan, 'Electric Motor Drives-Modeling, Analysis and Control', Prentice-Hall of<br/>India Pvt. Ltd., New Delhi, 2010</li> <li>Bimal K .Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd.,<br/>New Delhi, 2014.</li> <li>Reference Books:         <ul> <li>VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-<br/>Hill publishing company Ltd., New Delhi, 2009</li> <li>P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007</li> </ul> </li> </ul>  | 1  | G. K. Dubey," F<br>2011.  | undamentals of electric Drives, Narosa Publishing House", 2n  | d edition,                                      |  |  |  |  |  |  |
| <ul> <li>Bimal K .Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd.,<br/>New Delhi, 2014.</li> <li>Reference Books:         <ul> <li>VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2009</li> <li>P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007</li> </ul> </li> </ul>   | 2  | R. Krishnan, 'El<br>India Pvt. Ltd., I  | ectric Motor Drives-Modeling, Analysis and Control', Prentice-<br>New Delhi, 2010   | Hall of   |  |  |  |  |  |  |
| Reference Books:         1       VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-<br>Hill publishing company Ltd., New Delhi, 2009         2       P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007  | 3 Bimal K .Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt.Ltd.,<br>New Delhi, 2014. |   |   |   |  |  |  |  |  |  |
| 1         VedamSubramanyam, "Electric Drives-Concepts and Applications", Tata McGraw-<br>Hill publishing company Ltd., New Delhi, 2009           2         P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007   | Referen  | Reference Books:  |   |   |  |  |  |  |  |  |
| 2 P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 2007  | 1  | VedamSubrama<br>Hill publishing c   | anyam, "Electric Drives-Concepts and Applications", Tata McG<br>company Ltd., New Delhi, 2009   | iraw-   |  |  |  |  |  |  |
|   | 2  | P.C Sen "Thyris   | stor DC Drives", John wiely and sons, New York, 2007  |   |  |  |  |  |  |  |

| Web Re | Web References:   |  |  |  |  |  |
|--------|---|--|--|--|--|--|
| 1      | https://www.academia.edu/28273011/Review_of_Slip_Power_Recovery_Scheme                    |  |  |  |  |  |
| 2      | https://www.academia.edu/4953491/Real_Time_Control_of_Electrical_Machine_Drive s_A_Review |  |  |  |  |  |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy)   |                            |    |  |  |  |  |  |  |
|-------------------|---|----------------------------|----|--|--|--|--|--|--|
| Formative         | Assessment ba   | sed on Capstone Model      |    |  |  |  |  |  |  |
| Course<br>Outcome | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                            |    |  |  |  |  |  |  |
| C201.1            | Understand  | Online Quiz                | 20 |  |  |  |  |  |  |
| C201.2            | Analyse   | Class Presentation         | 20 |  |  |  |  |  |  |
| C201.3            | Understand  | Crown Appignment           |    |  |  |  |  |  |  |
| C201.4            | C201.4 Analyse Cloup Assignment 20  |                            |    |  |  |  |  |  |  |
| C201.5            | Apply   | C201.5 Apply Case Study 20 |    |  |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                   |                   |                          |  |  |  |  |  |
|--|-------------------|-------------------|--------------------------|--|--|--|--|--|
|  | Summative Ass     | essment (24%)     | End Semester Examination |  |  |  |  |  |
| Bloom's Level  | [120 N            | larks]            | (60%)                    |  |  |  |  |  |
|  | CIA1 : [60 Marks] | CIA2 : [60 Marks] | [100 Marks]              |  |  |  |  |  |
| Remember   | 10                | 10                | 10                       |  |  |  |  |  |
| Understand   | 30                | 30                | 30                       |  |  |  |  |  |
| Apply  | 10                | 10                | 10                       |  |  |  |  |  |
| Analyse  | 50                | 50                | 50                       |  |  |  |  |  |
| Evaluate   | -                 | -                 | -                        |  |  |  |  |  |
| Create   | -                 | -                 | -                        |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |             |  |  |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|--|--|
|               | End   |                                 |               |                                |                                 |             |  |  |  |
|               | Semester<br>Examination                                     |                                 |               |                                |                                 |             |  |  |  |
| SA 1          | FA 1 (4   | 0 Marks)                        | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)       |  |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |  |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | PO<br>6           | PO<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | РО<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C201.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C201.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C201.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C201.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C201.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C201.6           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | 3       |          | Strong   | y Agree  | ed       |          |          |

| 22PE202                  |   | Electric Vehicle and Power Management 3/0/0/3                                   |         |  |  |  |  |  |  |  |
|--------------------------|---|---|---------|--|--|--|--|--|--|--|
| Nature of                | Course  | E (Theory skill based)  |         |  |  |  |  |  |  |  |
| Course P                 | re-requisites   | Power Electronics, Electrical Machines  |         |  |  |  |  |  |  |  |
| Course O                 | bjectives:  |   |         |  |  |  |  |  |  |  |
| 1                        | 1 To understand the concept of electric vehicles and its operations   |   |         |  |  |  |  |  |  |  |
| 2                        | To present an their architectu  | overview of Electric Vehicle (EV), Hybrid Electric vehicle (HE)                 | /) and  |  |  |  |  |  |  |  |
| 3                        | To understand   | the need for energy storage in hybrid vehicles                                  |         |  |  |  |  |  |  |  |
| 4                        | To provide kno<br>be used in ele  | owledge about various possible energy storage technologies tl<br>ctric vehicles | nat can |  |  |  |  |  |  |  |
| Course O                 | utcomes:  |   |         |  |  |  |  |  |  |  |
| Upon con                 | npletion of the   | course, students shall have ability to  |         |  |  |  |  |  |  |  |
| C202.1                   | Interpret the o   | concept of electric vehicle and energy storage systems.                         | [U]     |  |  |  |  |  |  |  |
| C202.2                   | Examine the<br>Electric Vehic   | working and components of Electric Vehicle and Hybrid                           | [A]     |  |  |  |  |  |  |  |
| C202.3                   | Infer the ope applications  | ration of of power converters and electrical drives in industrial               | [AP]    |  |  |  |  |  |  |  |
| C202.4                   | Illustrate the c capacitors   | operation of storage systems such as battery and super                          | [U]     |  |  |  |  |  |  |  |
| C202.5                   | Analyze the v<br>hydrogen sto   | rarious energy storage systems based on fuel cells and rage                     | [A]     |  |  |  |  |  |  |  |
| Course C                 | ontents:  |   |         |  |  |  |  |  |  |  |
| Module 1:                | Electric Vehic  | cles and Vehicle Mechanics  | 15 Hrs  |  |  |  |  |  |  |  |
| internal cc<br>and HEV's | Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics. Architecture of EV's and HEV's-Plug-n Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes |   |         |  |  |  |  |  |  |  |

#### Module 2: Power Electronics and motor Drives

Electric drive components-Power electronic switches- four quadrant operation of DC drives -Induction motor and permanent magnet synchronous motor-based vector control operation -Switched reluctance motor (SRM) drives - EV motor sizing. Battery Basics- Different types-Battery Parameters-Battery life & safety impacts - Battery modeling-Design of battery for large vehicles.

### Module 3: Alternative Energy Storage Systems

Introduction to fuel cell- Types, Operation and characteristics- proton exchange membrane (PEM) fuel cell for E-mobility- hydrogen storage systems - Super capacitors for transportation applications.

| Text Books:         1       Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition"<br>CRC Press, Taylor & Francis Group, Second Edition (2011).         2       Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", |           |  |
|---|-----------|--|
| 1       Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition"         1       CRC Press, Taylor & Francis Group, Second Edition (2011).         2       Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems",        | Text Bool | ks:  |
| CRC Press, Taylor & Francis Group, Second Edition (2011).<br>Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems",  | 4         | Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition"   |
| Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems",   | 1         | CRC Press, Taylor & Francis Group, Second Edition (2011).                            |
|   | 2         | Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems",        |
| Special Indian Edition, Marcel dekker, Inc 2010.  | Z         | Special Indian Edition, Marcel dekker, Inc 2010.                                     |
| Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, Joh   | 2         | Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John |
| S Wiley & Sons,2017   | 3         | Wiley & Sons,2017  |
| Reference Books:  | Reference | e Books:   |
| 1 Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid   | 1         | Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid      |
| Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 200   |           | Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.  |

# 15 Hrs

15 Hrs

| 2        | C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University |
|----------|--|
|          | Press, 2001  |
| Web Refe | rences:  |
| 1.       | https://www.hyundai.com/in/en/find-a-car/kona electric/highlights.html           |
| 2.       | https://tech.hyundaimotorgroup.com/tag/futuretechnology/?gclid=EAIaIQobChMImdO   |
|          | Hi6T06AIViH0rCh2V4w5PEAAYASAAEgI90_D_BwE   |
| 3.       | https://afdc.energy.gov/files/pdfs/hev_ev_ghgreductions.pdf&ved=2ahUKEwi_tv-     |
|          | KpPToAhV06nMBHdeSAcQFjAAegQIBBAB&usg=AOvVaw2KfAnH97Y4gTmkGP5xJ                   |
|          | QWN  |

| Formative Summative<br>Assessment Assessment |     | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|--|-----|-------|-----------------------------------|-----------------------------|-------|
| 80   | 120 | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy)   |                                 |                    |    |  |  |  |  |  |  |  |
|---|---------------------------------|--------------------|----|--|--|--|--|--|--|--|
| Formative Assessment based on Capstone Model  |                                 |                    |    |  |  |  |  |  |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%)<br>[80 Marks] |                                 |                    |    |  |  |  |  |  |  |  |
| C202.1  | Understand                      | Online Quiz        | 20 |  |  |  |  |  |  |  |
| C202.2  | Analyze                         | Class Presentation | 20 |  |  |  |  |  |  |  |
| C202.3  | C202.3 Apply Assignment 20      |                    |    |  |  |  |  |  |  |  |
| C202.4  | C202.4 Understand Assignment 20 |                    |    |  |  |  |  |  |  |  |
| C202.5  | Analyze                         | Simulation Program | 20 |  |  |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |  |  |  |  |  |  |  |  |  |
|--|-------------------------|------------------------|--|--|--|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%)<br>[100 Marks] |  |  |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      |  |  |  |  |  |  |  |  |  |
| Understand   | 20                      | 20                     | 20   |  |  |  |  |  |  |  |  |
| Analyze  | 20                      | 20                     | 20   |  |  |  |  |  |  |  |  |
| Apply  | 30                      | 30                     | 30   |  |  |  |  |  |  |  |  |
| Understand   | 30                      | 30                     | 30   |  |  |  |  |  |  |  |  |
| Analyze  | -                       | -                      | -  |  |  |  |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |          |      |         |          |       |  |  |  |  |  |
|---------------|---|----------|------|---------|----------|-------|--|--|--|--|--|
|               | End   |          |      |         |          |       |  |  |  |  |  |
|               | Semester<br>Examination                                     |          |      |         |          |       |  |  |  |  |  |
| SA 1          | FA 1 (4   | 0 Marks) | SA 2 | FA 2 (4 | 0 Marks) | (60%) |  |  |  |  |  |
| (60<br>Marks) | [100 Marks]   |          |      |         |          |       |  |  |  |  |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | РО<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C202.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C202.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C202.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C202.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C202.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | ed      | 3        | 9        | Strong   | y Agree  | ed       |          |

| 22PE203  | Modelling and Design of SMPS 3/0/0/3   |  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|--|--|
| Nature of  | Course   | D (Theory Application)   |  |  |  |  |  |  |  |  |  |  |
| Course P   | re-requisites  | Power Electronics  |  |  |  |  |  |  |  |  |  |  |
| Course O   | bjectives:   |  |  |  |  |  |  |  |  |  |  |  |
| 1  | To inculcate k   | nowledge on steady state analysis of non-isolated DC-Dc con  | verter   |  |  |  |  |  |  |  |  |  |
| 2  | To perform ste   | To perform steady state analysis of Isolated DC-DC converter   |  |  |  |  |  |  |  |  |  |  |
| 3  | To educate on different converter dynamics   |  |  |  |  |  |  |  |  |  |  |  |
| 4  | To impart know   | To impart knowledge on the design of controllers for DC-DC converters  |  |  |  |  |  |  |  |  |  |  |
| 5  | 5 To familiarize the design magnetics for SMPS applications  |  |  |  |  |  |  |  |  |  |  |  |
| Course O   | utcomes:   |  |  |  |  |  |  |  |  |  |  |  |
| Upon con   | pletion of the   | course, students shall have ability to   |  |  |  |  |  |  |  |  |  |  |
| C203.1   | Analyze and c  | lesign Non-Isolated DC-DC converter  | [A]  |  |  |  |  |  |  |  |  |  |
| C203.2   | Analyze and c  | lesign Isolated DC-DC converter  | [A]  |  |  |  |  |  |  |  |  |  |
| C203.3   | Derive transfe   | er function of different converters  | [AP]   |  |  |  |  |  |  |  |  |  |
| C203.4   | Design contro  | Ilers for DC-DC converters   | [AP]   |  |  |  |  |  |  |  |  |  |
| C203.5   | Design magne   | etics for SMPS application   | [AP]   |  |  |  |  |  |  |  |  |  |
| Course C   | ontents:   |  |  |  |  |  |  |  |  |  |  |  |
| Module 1:<br>Buck, Boo<br>mode– Co<br>steady sta<br>design ex<br>converter:<br>topologies<br>Module 2:<br>AC equiva<br>modeling -<br>Module 3:<br>Review of<br>analysis -<br>theory rev<br>isolated to<br>wire gauge | Analysis of N<br>st, Buck- Boos<br>oncepts of volt<br>ite relationships<br>amples - App<br>Introduction -<br>design of SMP<br><b>Converter Dyn</b><br>Ilent circuit anal<br>Transfer functi<br><b>Controller and</b><br>P, PI, and PID<br>Design of cont<br>ision - Inducto<br>pologies - Ferre. | t and Cuk converters: Principles of operation - Continuous c<br>- sec balance and charge balance - Analysis and design<br>s - Introduction to discontinuous conduction mode - SEPIC to<br>lications to Battery operated vehicle, PV system. Isolate<br>classification- forward- flyback - pushpull - half bridge - f<br>S - Applications to Battery operated vehicle.<br><b>namics</b><br>lysis - State space averaging - Circuit averaging - Averaged sy<br>on model for buck, boost, buck-boost and cuk converters - Inp<br><b>d Magnetic Design</b><br>control concepts - gain margin and phase margin - Bode plot<br>troller for buck, boost, buck-boost and cuk converters. Basic<br>r design - Design of mutual inductance - Design of transfite<br>ite core table and selection of area product - wire table - se | 15 Hrs<br>onduction<br>based on<br>copology -<br>d DC-DC<br>ull bridge<br>15 Hrs<br>vitch<br>out filters.<br>15 Hrs<br>based<br>magnetic<br>ormer for<br>election of |  |  |  |  |  |  |  |  |  |
| Text Bool  | (6)  | I Otal Ho  | urs 45   |  |  |  |  |  |  |  |  |  |
| 1  | Robert W. Eric<br>Third Edition, 3   | ckson & Dragon Maksimovic, " Fundamentals of Power Electro<br>2030.  | onics",  |  |  |  |  |  |  |  |  |  |
| 2  | Philip T Krein,  | " Elements of Power Electronics", Oxford University Press, 20  | 17   |  |  |  |  |  |  |  |  |  |
| 3  | IssaBatarseh, edition, 2018  | Ahmad Harb, "Power Electronics- Circuit Analysis and Design  | , Second   |  |  |  |  |  |  |  |  |  |
| Reference  | e Books:   |  |  |  |  |  |  |  |  |  |  |  |
| 1  | Simon Ang an edition, 2011.  | d Alejandra Oliva, "Power-Switching Converters", CRC press,  | 3 <sup>rd</sup>  |  |  |  |  |  |  |  |  |  |
| 2  | W. G. Hurley a<br>Theory, Desig  | and W. H.Wolfle, "Transformers and Inductors for Power Elect n and Applications", 2013 Wiley, 1st Edition.   | ronics   |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

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|    | Hi6T06AIViH0rCh2V4w5PEAAYASAAEgI90_D_BwE                                     |
|----|--|
| 3. | https://afdc.energy.gov/files/pdfs/hev_ev_ghgreductions.pdf&ved=2ahUKEwi_tv- |
|    | KpPToAhV06nMBHdeSAcQFjAAegQIBBAB&usg=AOvVaw2KfAnH97Y4gTmkGP5xJ               |
|    | QWN  |

| Formative<br>Assessment | Formative Summative<br>Assessment Assessment |     | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|--|-----|-----------------------------------|-----------------------------|-------|
| 80                      | 120  | 200 | 40                                | 60                          | 100   |

| Assessme                         | Assessment Methods & Levels (based on Blooms' Taxonomy)   |                       |    |  |  |  |  |
|----------------------------------|---|-----------------------|----|--|--|--|--|
| Formative                        | Assessment ba   | sed on Capstone Model |    |  |  |  |  |
| Course<br>Outcome                | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                       |    |  |  |  |  |
| C203.1                           | Analyze   | Online Quiz           | 20 |  |  |  |  |
| C203.2                           | Analyze   | Class Presentation    | 20 |  |  |  |  |
| C203.3                           | Apply   | Group Assignment      | 20 |  |  |  |  |
| C203.4 Apply Group Assignment 20 |   |                       |    |  |  |  |  |
| C203.5                           | Apply   | Case Study            | 20 |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |
| Remember   | 20                      | 20                     | 20                                |  |  |  |
| Understand   | 20                      | 20                     | 20                                |  |  |  |
| Apply  | 30                      | 30                     | 30                                |  |  |  |
| Analyse  | 30                      | 30                     | 30                                |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |
| Create   | -                       | -                      | -                                 |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |             |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|
|               | End   |                                 |               |                                |                                 |             |  |
|               | Semester<br>Examination                                     |                                 |               |                                |                                 |             |  |
| SA 1          | FA 1 (40  | 0 Marks)                        | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)       |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |

| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | РО<br>6 | РО<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PO<br>12   | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|------------|----------|----------|----------|
| C203.1           | 3       | 1       | 1       | 1       |         |         |         |         |         |          |          |            |          | 2        |          |
| C203.2           | 3       | 2       | 2       | 1       |         |         |         |         |         |          |          |            |          | 2        |          |
| C203.3           | 3       | 2       | 1       |         |         |         |         |         |         |          |          | 3          |          | 2        |          |
| C203.4           | 3       | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2          |          | 3        |          |
| C203.5           | 3       | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2          |          | 3        |          |
| 1                | Reas    | sonab   | oly Ag  | greed   | 2       | Ν       | loder   | ately   | Agre    | ed       | 3        | <i>.</i> , | Strong   | y Agree  | ed       |

| 22PE205   | Electrical Drives Laboratory 0/0/4/2                                |  |               |              |  |  |  |
|-----------|---|--|---------------|--------------|--|--|--|
| Nature of | Course  | M (Practical application)                              |               |              |  |  |  |
| Pre-requi | sites   | Power Electronics                                      |               |              |  |  |  |
| Course C  | Course Objectives:  |  |               |              |  |  |  |
| 1         | To know the   | DC motor performance with controlled converter and c   | hopper.       |              |  |  |  |
| 0         | To gain know  | wledge about the Vector controlled induction motor a   | and to verify | / their      |  |  |  |
| 2         | performance   | -  |               |              |  |  |  |
| 3         | To Implemen   | t IGBT based SVPWM inverter.                           |               |              |  |  |  |
| 4         | To control the  | e speed of Induction and SRM motor by DSP controlle    | r.            |              |  |  |  |
| Course C  | utcomes:  |  |               |              |  |  |  |
| Upon cor  | npletion of th  | e course, students shall have ability to               |               |              |  |  |  |
| C205.1    | Analyze the p   | performance of DC and AC motor.                        |               | [A]          |  |  |  |
| C205.2    | Analyze the p   | performance characteristics of DC and AC motor in      |               | [A]          |  |  |  |
|           | Regenerative  | e/ Dynamic breaking.                                   |               |              |  |  |  |
| C205.3    | Understand t  | he PLC based motor control.                            |               | [U]          |  |  |  |
| C205.4    | Apply DSP c   | ontroller to the Induction SRM.                        |               | [A]          |  |  |  |
| C205 5    | Analyze the r   | performance of DC and AC motor                         |               | [A]          |  |  |  |
| 0200.0    |   |  |               | [, ,]        |  |  |  |
| Course C  | ontents:  |  | 00            |              |  |  |  |
| S.No      |   | List of Experiments                                    | CO<br>Manning | RBT          |  |  |  |
| 1.        | Speed control of DC motor using three phase fully controlled C205.1 |  |               |              |  |  |  |
| 2         | Simulation of closed loop control of Converter fed DC drive         |  |               |              |  |  |  |
|           | Regenerative/ Dynamic breaking operation for DC motor study         |  |               |              |  |  |  |
| 3.        | using software.   |  |               |              |  |  |  |
| 4.        | Regenerative/ Dynamic breaking operation for AC motor study C205.2  |  |               |              |  |  |  |
| 5.        | PLC based /   | AC motor control operation.                            | C205.3        | [AP]         |  |  |  |
| 6.        | DSP based   | speed control of SRM motor.                            | C205.4        | [AP]         |  |  |  |
| 7         | Speed contr   | ol of Induction motor drive.                           | C205.5        | [[ ]]        |  |  |  |
| 8.        | Performance   | e study of Stator Voltage Controlled Induction Motor   | C205.5        | [A]          |  |  |  |
| 9         | Vector Conti  | rolled Induction Motor Drive                           | C205 5        | [A]          |  |  |  |
| 10        | Speed contr   | ol of BLDC motor                                       | C205.5        | [Λ]<br>[Δ]   |  |  |  |
| 10.       | epool contra  | Total Hours  | 200.0         | <u>[/ \]</u> |  |  |  |
| Text Boo  | ks:   |  |               | •            |  |  |  |
| 1         | G. K. Dubey,  | "Fundamentals of Electric Drives, Narosa Publishing I  | House", 2nd   | edition,     |  |  |  |
| 2         | R. Krishnan,  | 'Electric Motor Drives-Modeling, Analysis and Control' | , Prentice-H  | all of       |  |  |  |
| 3         | BimalK .Bose  | e, 'Modern Power Electronics and AC Drives', Pearson   | Education     | Pvt.         |  |  |  |
| Referenc  | e Books:  |  |               |              |  |  |  |
| 1         | VedamSubra  | amanyam, "Electric Drives-Concepts and Applications",  | Tata          |              |  |  |  |
|           | McGraw-Hill publishing company Ltd., New Delhi, 2009                |  |               |              |  |  |  |
| 2         | P.C Sen Th  | yristor JU Urives, John wiely and sons, New York, 20   | J7.           |              |  |  |  |
| Web Refe  | erences:  |  |               |              |  |  |  |
| 1         | https://www.a   | academia.edu/28273011/Review_of_Slip_Power_Reco        | overy_Schei   | ne           |  |  |  |
| 2         | https://www.a<br>s_A_Review   | academia.edu/4953491/Real_Time_Control_of_Electri      | cal_Machine   | e_Drive      |  |  |  |

|                         | Continuous Ass          | sessment |                                |                             |       |
|-------------------------|-------------------------|----------|--------------------------------|-----------------------------|-------|
| Formative<br>Assessment | Summative<br>Assessment | Total    | Total Continuous<br>Assessment | End Semester<br>Examination | Total |
| 75                      | 25                      | 100      | 60                             | 40                          | 100   |

| Assessment based on Continuous and End Semester Examination |                      |                                       |                      |  |  |  |
|---|----------------------|---------------------------------------|----------------------|--|--|--|
| Bloom's Level   | Continuous A<br>[100 | End Semester<br>Practical Examination |                      |  |  |  |
|   | FA<br>(75 Marks)     | SA<br>(25 Marks)                      | (40%)<br>[100 Marks] |  |  |  |
| Remember  | -                    | -                                     | -                    |  |  |  |
| Understand  | -                    | -                                     | -                    |  |  |  |
| Apply   | 60                   | 60                                    | 60                   |  |  |  |
| Analyse   | 30                   | 30                                    | 30                   |  |  |  |
| Evaluate  | 10                   | 10                                    | 10                   |  |  |  |
| Create  | -                    | -                                     | -                    |  |  |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | РО<br>4 | PO<br>5 | PO<br>6           | PO<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | РО<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C205.1           | 3       | 3       | 2       | 2       |         |                   | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C205.2           | 3       | 2       | 1       | 1       |         |                   | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C205.3           | 3       | 3       | 2       | 2       | 3       |                   | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C205.4           | 3       | 2       | 1       | 1       |         |                   | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| C205.5           | 3       | 2       | 1       | 1       |         |                   | 1       | 2       | 2       | 2        |          |          | 3        |          | 3        |
| 1                | Rea     | sonab   | oly Ag  | reed    | 2       | Moderately Agreed |         |         | 3       |          | Strongl  | y Agree  | d        |          |          |



| 22PE501  | Distributed Generation and Micro Grids                         |      |  |  |  |  |  |
|--|--|------|--|--|--|--|--|
| Nature of Course                                 | D (Theory Application)   |      |  |  |  |  |  |
| Course Pre-requisites Renewable Energy Resources |  |      |  |  |  |  |  |
| Course Objectives:                               |  |      |  |  |  |  |  |
| 1 To develop a                                   | a conceptual introduction to various distributed generation.   |      |  |  |  |  |  |
| 2 To analyze t                                   | he impact of grid integration.                                 |      |  |  |  |  |  |
| 3 To know abo                                    | out the structures of micro grids and various control schemes. |      |  |  |  |  |  |
| Course Outcomes:                                 |  |      |  |  |  |  |  |
| Upon completion of t                             | he course, students shall have ability to                      |      |  |  |  |  |  |
| C501.1 Examine the                               | various distributed generation systems and IEEE standards.     | [A]  |  |  |  |  |  |
| C501.2 Interpret the                             | operation of energy storage elements in distributed generation | [U]  |  |  |  |  |  |
| C501.3 Analyze the                               | Grid integration issues and stability.                         | [A]  |  |  |  |  |  |
| C501.4 Infer the AC                              | and DC micro grid structures and its interface.                | [AP] |  |  |  |  |  |
| C501.5 Classify the                              | various control schemes of micro grid .                        | [A]  |  |  |  |  |  |
| Course Contents:                                 |  |      |  |  |  |  |  |

### **Module 1: Distributed Generations**

Concept of distributed generations-topologies-selection of sources - regulatory standards/ framework - Standards for interconnecting Distributed resources to electric power systems: IEEE 1547 - DG installation classes - security issues in DG implementations - Energy storage elements: Batteries, ultra-capacitors, flywheels - Captive power plants.

#### Module 2: Impact of Grid Integration

Requirements for grid interconnection - limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions - islanding issues - Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

### Module 3: Microgrids

Concept and definition of microgrid - microgrid drivers and benefits - review of sources of microgrids - typical structure and configuration of a microgrid - AC and DC microgrids - Power Electronics interfaces in DC and AC microgrids - communication infrastructure-modes of operation and control of microgrid -grid connected and islanded mode - Active and reactive power control-protection issues - anti-islanding schemes: passive, active and communication based techniques.

|           | Total Hours 45   |
|-----------|--|
| Text Boo  | oks:   |
| 1         | Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power             |
| I         | Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2010.    |
|           | Gevork B. Gharehpetian S. Mohammad Mousavi Agah "Distributed Generation              |
| 2         | Systems-Design, Operation and Grid Integration "Butterworth-Heinemann                |
|           | Publications,1st Edition May 2017  |
| 2         | Dorin O Neacsu, "Power Switching Converters: Medium and High Power", CRC             |
| 3         | Press, Taylor & Francis, 2014  |
| Reference | ce Books:  |
| 1         | Nikos Hatziargyriou "Microgrids: Architectures and Control" John Wiley Publications, |
|           | 2014   |
| 2         | F. Manwell, J.G. McGowan "Wind Energy Explained, theory design and applications",    |
|           | Wiley publication 2010.  |
| Web Ref   | erences:   |
| 1         | https://www.edx.org/course/solar-energy-integration-of-photovoltaic-systems-in-      |
|           | microgrids   |
| 2         | https://www.coursera.org/lecture/electric-utilities/5-3-microgrids-PK58x             |

# 15 Hrs

15 Hrs

15 Hrs

|                         | Continuous Assessment   |       |                                   |                             |       |  |  |  |  |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|--|--|--|--|
| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |  |  |  |  |
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |  |  |  |  |

| Assessme  | Assessment Methods & Levels (based on Blooms' Taxonomy) |                       |    |  |  |  |  |
|---|---|-----------------------|----|--|--|--|--|
| Formative   | Assessment ba   | sed on Capstone Model |    |  |  |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%)<br>[80 Marks] |   |                       |    |  |  |  |  |
| C501.1  | Analyze   | Online Quiz           | 20 |  |  |  |  |
| C501.2  | Understand  | Class Presentation    | 20 |  |  |  |  |
| C501.3  | Analyze   | Group Assignment      | 20 |  |  |  |  |
| C501.4  | C501.4 Apply Group Assignment 20                        |                       |    |  |  |  |  |
| C501.5  | Analyze   | Case Study            | 20 |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>Iarks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |                  |                                |                                 |                         |  |  |  |
|---|--------------------------------|---------------------------------|------------------|--------------------------------|---------------------------------|-------------------------|--|--|--|
| Continuous Assessment (40%)<br>[200 Marks]                  |                                |                                 |                  |                                |                                 | End                     |  |  |  |
| CA 1 : 100 Marks  |                                |                                 | CA 2 : 100 Marks |                                |                                 | Semester<br>Examination |  |  |  |
| SA 1<br>(60<br>Marks)                                       | FA 1 (40 Marks)                |                                 | SA 2             | FA 2 (40 Marks)                |                                 | (60%)                   |  |  |  |
|   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks)    | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |  |  |
| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | РО<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C501.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C501.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C501.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C501.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C501.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Rea     | sonab   | ly Ag   | reed    | 2       | Moderately Agreed |         |         | 3       |          | Strong   | y Agree  | d        |          |          |

| Course O   | bjectives:   |                    |  |  |  |  |  |  |  |  |  |
|--|--|--------------------|--|--|--|--|--|--|--|--|--|
| 1  | To know the different power quality issues and IEEE standards with recommended practices.  |                    |  |  |  |  |  |  |  |  |  |
| 2  | To estimate the various types of harmonics, sag and mitigation techniques usi filters.   | ng                 |  |  |  |  |  |  |  |  |  |
| 3 To understand the compensation techniques used for power factor correction and loadvoltage regulation. |  |                    |  |  |  |  |  |  |  |  |  |
| Course Outcomes:   |  |                    |  |  |  |  |  |  |  |  |  |
| Upon con   | npletion of the course, students shall have ability to   |                    |  |  |  |  |  |  |  |  |  |
| C502.1   | Interpret the various power quality issues, standards with recommended [U]   |                    |  |  |  |  |  |  |  |  |  |
| C502.2   | Acquire knowledge about the harmonics, harmonic introducing devices and analyze effect of harmonics on system equipment's and loads.   | [A]                |  |  |  |  |  |  |  |  |  |
| C502.3   | Understand the active and passive power filtering techniques for harmonics.  | [U]                |  |  |  |  |  |  |  |  |  |
| C502.4   | Analyze the different types of load balancing problem in the power system  | [A]                |  |  |  |  |  |  |  |  |  |
| C502.5   | conditioning equipment's.  | [AP]               |  |  |  |  |  |  |  |  |  |
| Course C   | ontents:   |                    |  |  |  |  |  |  |  |  |  |
| Module 1:<br>Source of<br>internation  | Review of various power quality (PQ) problems1generation and their impacts on equipment and systems - need of monital power quality standards (IEEE Standards) and recommended practices.  | 5 Hrs<br>itoring - |  |  |  |  |  |  |  |  |  |
| Important<br>saturable o<br>on power<br>Harmonic<br><b>Module 3</b> :<br>Principle o                     | Individual and total harmonic distortion RMS value of a harmonic waveform Triplex harmonics -<br>Important harmonic introducing devices - SMPS Three phase power converters-arcing devices,<br>saturable devices - Harmonic distortion of fluorescent lamps - Effect of power system harmonics<br>on power system equipment and loads - Overview of active and passive filters for harmonics -<br>Harmonic reduction and voltage sag reduction.<br><b>Module 3: Compensation Methods</b><br>Drinciple of load companyation and voltage regulation. |                    |  |  |  |  |  |  |  |  |  |
| loop bala  | ncing - Closed loop balancing, Current balancing - Analysis of unbal   | ance -             |  |  |  |  |  |  |  |  |  |
| Instantane   | ous real and reactive powers - Extraction of fundamental sequence componer   | nt. DVR            |  |  |  |  |  |  |  |  |  |
| - DVR stru<br>Overview (   | icture - Voltage restoration - Series active filter - Unified Power Quality Condi<br>of DSTATCOM   | tioner -           |  |  |  |  |  |  |  |  |  |
|  | Total Hou  | rs 45              |  |  |  |  |  |  |  |  |  |
| Text Bool  | <s:< td=""><td></td></s:<>   |                    |  |  |  |  |  |  |  |  |  |
| 1  | Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Probl and Mitigation Techniques", John Wiley & Sons, 2015.   | ems                |  |  |  |  |  |  |  |  |  |
| 2  | Ewald Fuchs, Mohammad A. S. Masoum Power Quality in Power Syst<br>and Electrical Machines, Elseveir academic press publications, 2011  | ems                |  |  |  |  |  |  |  |  |  |
| 3  | G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007   |                    |  |  |  |  |  |  |  |  |  |
| Reference  | e Books:   |                    |  |  |  |  |  |  |  |  |  |
| 1  | 1       Ahmed F. Zobaa, Shady H.E. Abdel Aleem and Murat E. Balci, "Power System Harmonics - Analysis, Effects, and Mitigation Solutions for Power Quality Improvement", Intec open 2018.  |                    |  |  |  |  |  |  |  |  |  |
| 2  | ArindamGhosh "Power Quality Enhancement Using Custom Power Device (Power Electronics and Power Systems)', Springer; 2008.  | S",                |  |  |  |  |  |  |  |  |  |
| Web Refe   | rences:  |                    |  |  |  |  |  |  |  |  |  |
| 1.   | https://nptel.ac.in/courses/108105066/16   |                    |  |  |  |  |  |  |  |  |  |
| 2.   | https://nptel.ac.in/courses/112107240/29   |                    |  |  |  |  |  |  |  |  |  |
| R2022  | M.E Power Electronics and Drives   | Page 37            |  |  |  |  |  |  |  |  |  |

**Power Quality** 

D (Theory Application)

22PE502

Nature of Course

Course Pre-requisites Nil

| 3. | https://nptel.ac.in/courses/108107114/35   |
|----|--|
| 4. | https://www.powerstandards.com/tutorials/ieee-power-quality-standards/           |
| F  | https://www.researchgate.net/publication/228413035_Harmonic_distortion_caused_by |
| 5. | <pre>_ compact_fluorescent_lights_on_electrical_networks</pre>                   |
| 6. | https://www.researchgate.net/publication/273203160_Power_Conditioning_Using_Dy   |
|    | namic_Voltage_Restorers_under_Different_Voltage_Sag_Types/figures?lo=1           |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy)   |                    |    |  |  |  |  |  |  |
|-------------------|---|--------------------|----|--|--|--|--|--|--|
| Formative         | Formative Assessment based on Capstone Model  |                    |    |  |  |  |  |  |  |
| Course<br>Outcome | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                    |    |  |  |  |  |  |  |
| C502.1            | Understand  | Online Quiz        | 20 |  |  |  |  |  |  |
| C502.2            | Analyze   | Class Presentation | 20 |  |  |  |  |  |  |
| C502.3            | Understand  | Group Assignment   | 20 |  |  |  |  |  |  |
| C502.4            | 02.4 Analyze Group Assignment 20  |                    |    |  |  |  |  |  |  |
| C502.5            | Apply   | Case Study         | 20 |  |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |             |  |  |  |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|--|--|--|
|               | End   |                                 |               |                                |                                 |             |  |  |  |  |
|               | Semester<br>Examination                                     |                                 |               |                                |                                 |             |  |  |  |  |
| SA 1          | FA 1 (4   | 0 Marks)                        | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)       |  |  |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |  |  |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | РО<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10        | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|---------|-------------------|---------|---------|---------|-----------------|----------|----------|----------|----------|----------|
| C502.1           | 3                 | 1       | 1       | 1       |         |                   |         |         |         |                 |          |          |          | 2        |          |
| C502.2           | 3                 | 2       | 2       | 1       |         |                   |         |         |         |                 |          |          |          | 2        |          |
| C502.3           | 3                 | 2       | 1       |         |         |                   |         |         |         |                 |          | 3        |          | 2        |          |
| C502.4           | 3                 | 3       | 3       | 2       |         | 1                 | 1       |         |         |                 |          | 2        |          | 3        |          |
| C502.5           | 3                 | 3       | 3       | 2       |         | 1                 | 1       |         |         |                 |          | 2        |          | 3        |          |
| 1                | Reasonably Agreed |         |         | greed   | 2       | Moderately Agreed |         |         | 3       | Strongly Agreed |          |          |          |          |          |

| 22PE503                   | G  | Grid Integration of Renewable Energy Sources 3/0/0              |       |  |  |  |  |  |  |  |
|---------------------------|--|---|-------|--|--|--|--|--|--|--|
| Nature of                 | Course   | D (Theory Application)  |       |  |  |  |  |  |  |  |
| Course Pre-requisites Nil |  |   |       |  |  |  |  |  |  |  |
| Course O                  | bjectives:   |   |       |  |  |  |  |  |  |  |
| 1                         | To study abou  | It the integration of various renewable energy sources into the | grid. |  |  |  |  |  |  |  |
| 2                         | To analyze va  | rious grid issues due to renewable energy sources               |       |  |  |  |  |  |  |  |
| 3                         | To analyze the   | e dynamics of network due to wind farm                          |       |  |  |  |  |  |  |  |
| 4                         | To provide knowledge about power system stabilizers.               |   |       |  |  |  |  |  |  |  |
| 5                         | To provide knowledge about grid connected and standalone PV system |   |       |  |  |  |  |  |  |  |
| Course O                  | utcomes:   |   |       |  |  |  |  |  |  |  |
| Upon con                  | pletion of the   | course, students shall have ability to                          |       |  |  |  |  |  |  |  |
| C503.1                    | Infer the integ  | ration of various renewable energy sources into the grid        | [U]   |  |  |  |  |  |  |  |
| C503.2                    | Analyze variou   | us grid issues due to renewable energy sources                  | [A]   |  |  |  |  |  |  |  |
| C503.3                    | Compute the  | dynamics of network due to wind energy integration              | [AP]  |  |  |  |  |  |  |  |
| C503.4                    | Interpret the o  | peration of power system stabilizers.                           | [U]   |  |  |  |  |  |  |  |
| C503.5                    | Design the gri   | d connected and standalone PV system.                           | [A]   |  |  |  |  |  |  |  |
| Course C                  | ontents:   |   |       |  |  |  |  |  |  |  |
| Module 1:                 | Module 1: Network Management 15 Hrs                                |   |       |  |  |  |  |  |  |  |

## Module 1: Network Management

Introduction to renewable energy and grid integration - Network voltage management - Power quality management (voltage dips, harmonics, flickers, and reactive power control) - Frequency management-Influence of WECS on system transient response - Interconnection standards and grid code requirements for integration.

#### Module 2: Influence of Wind Farms on Network Dynamic Performance

Dynamic Stability and its Assessment-Dynamic characteristics of Synchronous Generation - A Synchronizing power and Damping power model of a Synchronous Generator-Influence of Automatic Voltage Regulator on Damping-Influence on Damping of Generator Operating Conditions-Influence of Turbine Governor on Generator Operation-Transient Stability -Voltage Stability-Influence of Generation Type on Network Dynamic Stability-Dynamic Interaction of Wind Farms with the Network-influence of Wind Generation on Network Transient Performance. A Power System Stabilizer for a Synchronous Generator - A Power System Stabilizer for a DFIG -A Power System Stabilizer for a FRC Wind Farm.

#### Module 3: Stand Alone and Grid Connected PV System

Solar modules-storage systems-Basics of batteries-Batteries for PV Systems-Charge Controllers-MPPT and Inverters-Power Conditioning and Regulation-protection-Types of Solar PV systems - standalone PV systems design-sizing-PV systems in buildings-design issues for central power stations-safety-Economic aspect-efficiency and performance-International PV programs Total Hours 15

| Text Bool | (S:   |
|-----------|---|
| 1         | Stuart R.Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, 'Applied  |
| 1         | Photovoltaics', Earthscan, UK, 2007.  |
| 2         | Joshua Earnest, 'Wind power technology', II Edition, PHI, 2015.                 |
|           | Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, Phill Cartwright and Mike    |
| 3         | Hughes, 'Wind Generation Modelling and Control', A John Wiley and Sons, Ltd.,   |
|           | Publication, 2009.  |
| Reference | e Books:  |
| 1         | Brenden Fox, Damian Flynn and Leslie Bryans, 'Wind Power Integration Connection |
|           | and system operational aspects', Published by The Institute of Engineering and  |
|           | Technology, London, United Kingdom, 2007.                                       |
| 2         | Frank S. Barnes & Jonah G.Levine, 'Large Energy Storage Systems Handbook', CRC  |

15 Hrs

15 Hrs

|          | Press, 2011.   |  |  |  |  |  |  |  |
|----------|--|--|--|--|--|--|--|--|
| 3        | Chetan Singh Solanki, 'Solar Photovoltaic Technology and Systems'-A Manual for     |  |  |  |  |  |  |  |
|          | Technicians, Trainees and Engineers, PHI, 2014.                                    |  |  |  |  |  |  |  |
| Web Refe | Web References:  |  |  |  |  |  |  |  |
| 1.       | https://www.rff.org/publications/explainers/renewables-101-integrating-renewables/ |  |  |  |  |  |  |  |
| 2.       | https://pcmp.springeropen.com/articles/10.1186/s41601-021-00181-3                  |  |  |  |  |  |  |  |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy) |  |                        |  |  |  |  |  |
|-------------------|---|--|------------------------|--|--|--|--|--|
| Formative         | Formative Assessment based on Capstone Model            |  |                        |  |  |  |  |  |
| Course<br>Outcome | Bloom's<br>Level  | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |  |  |
| C503.1            | Understand  | Online Quiz  | 20                     |  |  |  |  |  |
| C503.2            | Analyze   | Class Presentation   | 20                     |  |  |  |  |  |
| C503.3            | Apply   | Assignment   | 20                     |  |  |  |  |  |
| C503.4            | Understand  | Assignment   | 20                     |  |  |  |  |  |
| C503.5            | Analyze   | Case Study   | 20                     |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |  |  |
| Remember   | 10                      | 10                     | 10                                |  |  |  |  |  |
| Understand   | 30                      | 30                     | 30                                |  |  |  |  |  |
| Apply  | 10                      | 10                     | 10                                |  |  |  |  |  |
| Analyse  | 50                      | 50                     | 50                                |  |  |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |  |  |
| Create   | -                       | -                      | -                                 |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |                         |  |  |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------------------|--|--|--|
|               | Continuous Assessment (40%)<br>[200 Marks]                  |                                 |               |                                |                                 |                         |  |  |  |
|               | CA 1 : 100 Ma   | arks                            |               | CA 2 : 100 Ma                  | arks                            | Semester<br>Examination |  |  |  |
| SA 1          | FA 1 (4   | 0 Marks)                        | SA 2          | FA 2 (40 Marks)                |                                 | (60%)                   |  |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |  |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8       | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------------|---------|----------|----------|----------|----------|----------|----------|
| C503.1           | 3       | 1       | 1       | 1       |         |         |         |               |         |          |          |          |          | 2        |          |
| C503.2           | 3       | 2       | 2       | 1       |         |         |         |               |         |          |          |          |          | 2        |          |
| C503.3           | 3       | 2       | 1       |         |         |         |         |               |         |          |          | 3        |          | 2        |          |
| C503.4           | 3       | 3       | 3       | 2       |         | 1       | 1       |               |         |          |          | 2        |          | 3        |          |
| C503.5           | 3       | 3       | 3       | 2       |         | 1       | 1       |               |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | 2 Mode  |         | rately Agreed |         | 3        | 9        | Strong   | y Agree  | ed       |          |

| Course P              | re-requisites                        | Power Electronics, Control Systems   |                   |
|-----------------------|--------------------------------------|--|-------------------|
| Course O              | bjectives:                           |  |                   |
| 1                     | To expose the                        | e basic theoretical and practical applications of power  |                   |
| 2                     | Understand the                       | e protection and control circuit for the semiconductor devices   |                   |
| Course O              | utcomes:                             |  |                   |
| Upon con              | npletion of the                      | course, students shall have ability to   |                   |
| C504.1                | Design and ar                        | nalysis the current controlled power semiconductordevices.   | [A]               |
| C504.2                | Design and a<br>Devices              | nalysis the voltage controlled power semiconductor   | [A]               |
| C504.3                | Select firing ar<br>switches.        | nd protection circuit for different power semiconductor  | [U]               |
| C504.4                | Understand semiconductor             | the methods of thermal protection for different devices  | [U]               |
| C504.5                | Analyze and de                       | esign various power electronics devices  | [A]               |
| Course C              | ontents:                             |  |                   |
| Module 1              | Current contr                        | olled devices 1  | 5 Hrs             |
| Power Did             | de. Thyristors                       | and BJT's-Construction, static and dynamic characteristics; N  | legative          |
| temperatu             | re coefficient a                     | and secondary breakdown- Power Darlington - series and   | parallel          |
| operation.            | comparison of                        | B IT and Thyristor - Steady state and dynamic models of F  | NT and            |
| Thyristor -           | Simulation of T                      | byristor and BIT   |                   |
| Thynstol -            |                                      |  |                   |
| Module 2:<br>Power MC | <b>Voltage contr</b><br>SFETs and IG | olled devices<br>BTs-Principle of voltage controlled devices, construction, type<br>tics-series and parallel operation. Steady state and dynamic m | 5 Hrs<br>s Static |
| MOSEET                | and IGBTs Ba                         | sics of GTO MCT FCT RCT and IGCT - Simulation of MOSE  | FT and            |
| IGBT.                 |                                      |  |                   |
| -                     |                                      |  |                   |
| Module 3              | : Firing and the                     | ermal protection circuits 1  | 5 Hrs             |
| Necessity             | of isolation, pu                     | ulse transformer, opto coupler - Gate drives circuit: SCR, M   | OSFET,            |
| IGBTs and             | d base driving f                     | or power BJT, Over voltage, over current and gate protections,   | Design            |
| of snubbe             | rs. Heat transfe                     | er-conduction, convection and radiation, Cooling-liquid cooling,   | vapour-           |
| phase coo             | oling, Guidance                      | for heat sink selection-Thermal resistance and impedance, E  | lectrical         |
| analogy of            | thermal compo                        | onents, heat sink types and design-Mounting types.   |                   |
| Tavé Da al            | ka.                                  | l otal Houi  | rs 45             |
| Text Boo              |                                      |  |                   |
| 1                     | Rashid M.H.,                         | "Power Electronics Circuits, Devices and Applications", Prer   | ntice             |
|                       | HallIndia, 3 <sup>rd</sup>           | Edition, New Delhi, 2013.  | 4                 |
| 2                     | MD Singh and                         | K.B.K.nanchandani, "Power Electronics", Tata McGraw Hill, 201  | 4.                |
| 3                     | 2ndEdition 20                        | a Jain Modelling and Simulation using MATLAB Simulink, Wiley,  |                   |
| Reference             | e Books:                             |  |                   |
| 1                     | Ned Mohan.                           | Tore M. Undeland, William P.Robbins, "Power Electronics con  | verters.          |
|                       | Applications, a                      | and Design", 3 rd Edition, John Wiley & Sons, 2009.  |                   |
| 2                     | Joseph Vithay                        | vathil, Power Electronics: Principles and Applications, Delhi,   | Tata              |
|                       | McGraw-Hill, 2                       | 2010.  |                   |
| Web Refe              | erences:                             |  |                   |
| 1.                    | http://www.npt<br>Electronics/PI     | tel.ac.in/courses/Webcourse-contents/IITKharagpur/Power<br>DF/   |                   |
| 2.                    | https://pcmp.s                       | pringeropen.com/articles/10.1186/s41601-021-00181-3  |                   |
|                       | · · ·                                | · · · ·  |                   |
|                       |                                      |  |                   |

**Power Semiconductor Devices and Modelling** 

22PE504

Nature of CourseE (Theory skill based)

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy) |  |                        |  |  |  |  |
|-------------------|---|--|------------------------|--|--|--|--|
| Formative         | Assessment ba   | sed on Capstone Model  |                        |  |  |  |  |
| Course<br>Outcome | Bloom's<br>Level  | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |  |
| C504.1            | Analyze   | Online Quiz  | 20                     |  |  |  |  |
| C504.2            | Analyze   | Presentation   | 20                     |  |  |  |  |
| C504.3            | Understand  | Assignment   | 20                     |  |  |  |  |
| C504.4            | Understand  | Assignment   | 20                     |  |  |  |  |
| C505.5            | Analyze   | Simulation Program   | 20                     |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |  |  |
| Remember   | 20                      | 20                     | 20                                |  |  |  |  |  |
| Understand   | 20                      | 20                     | 20                                |  |  |  |  |  |
| Apply  | 30                      | 30                     | 30                                |  |  |  |  |  |
| Analyse  | 30                      | 30                     | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |  |  |
| Create   | -                       | -                      | -                                 |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |                         |  |  |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------------------|--|--|--|
|               | End   |                                 |               |                                |                                 |                         |  |  |  |
|               | CA 1 : 100 Ma   | nrks                            |               | CA 2 : 100 Ma                  | arks                            | Semester<br>Examination |  |  |  |
| SA 1          | FA 1 (40 Marks)   |                                 | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)                   |  |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |  |  |

| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | РО<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C504.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C504.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C504.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C504.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C504.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | 3       | 9,       | Strong   | y Agree  | ed       |          |          |

| 22PE505   |   | Modern Rectifiers and Resonant Converters  | 3/0/0/3  |
|---|---|--|--|
| Nature of   | Course  | G (Theory Analytical)  |  |
| Course F  | re-requisites   | Power Electronics  |  |
| Course C  | bjectives:  |  |  |
| 1   | To gain know<br>Continuous C  | ledge about the harmonics standards and operation of rectific<br>onduction Mode (CCM) and Discontinuous Conduction Mode (  | ⊧rs in<br>DCM).  |
| 2   | To analyze an<br>Supply(UPS)  | nd design power factor correction rectifiers for Uninterrupted Po<br>applications.   | wer  |
| 3   | To know the o (SMPS) applic   | operation of resonant converters for Switched Mode Power Su<br>cations.  | ylqq   |
| 4   | To carry out d  | lynamic analysis of DC- DC Converters.   |  |
| 5   | To introduce t  | he source current shaping methods for rectifiers   |  |
| Course O  | utcomes:  | agurag, students shall have shility to   |  |
| C505 1  | Apply the con   | cont of various types of rectifiers  |  |
| 0303.1  | Simulate and  | design the operation of reconant converter and its   |  |
| C505.2  | importance.   |  | [AP]   |
| C505.3  | Identify the im   | portance of linear system, state space model, PI controller.   | [U]  |
| C505.4  | Design the DC   | C power supplies using advanced techniques.  | [A]  |
| C505.5  | Infer the stand   | dards for supply current harmonics and its significance.   | [U]  |
| Course C  | contents:   |  |  |
| CCM and<br>large and<br>rectifier- 1<br>Module 2<br>Properties<br>converter<br>rectifiers<br>based PV<br>applicatio<br>converters<br>multi reso<br>zero volta | DCM operation<br>DCM operation<br>2 pulse convert<br><b>: Pulse Width I</b><br>s of Ideal singl<br>systems incorp<br>-single- phase<br>/M rectifier, con<br>ns of rectifiers.<br>s- basics of ZVS<br>onant converters<br>ge transition PV | <ul> <li>Impedance - AC line current narmonic standards IEC1000-in of single phase full wave rectifier- Behaviour of full wave rectifier of capacitance - CCM and DCM operation of three phase ters - Harmonic trap filters.</li> <li>Modulated Rectifiers and Resonant Converters le phase rectifiers-Realization of nearly ideal rectifier Sing porating ideal rectifiers - Losses and efficiency in CCM hig PWM rectifier -PWM concepts - device selection for rectifier nparison with SCR based converters with respect to harmonic Soft Switching - classification of resonant converters - Quasi S and ZCS- half wave and full wave operation (qualitative trees - operation and analysis of ZVS and ZCS multi resonant converters.</li> </ul> | <b>15 Hrs</b><br>gle-phase<br>gh quality<br>rs - IGBT<br>content -<br>resonant<br>eatment) -<br>onverter -       |
| Rectifiers<br>Review of<br>State Spa<br>Boost Co<br>Scheme<br>power fac<br>shaping<br>rectifier e<br>Nonlinear<br><b>Text Boo</b>                             | f linear system<br>ace Averaged n<br>nverter and an<br>Current Mode<br>ctor - functions<br>methods -inpu<br>mploying peal<br>carrier control.   | analysis-State Space Averaging-Basic State Space Average<br>nodel for an ideal Buck Converter, ideal Boost Converter, id<br>ideal Cuk Converter. Pulse Width modulation - Voltage Mo<br>e PWM Scheme - design of PI controller. Need for current<br>of current shaper - input current shaping methods - part<br>it inductor filter - resonant input filter - active methol<br>k current control - average current control - Hysteresis<br>Total Ho   | 15 Hrs<br> e Model-<br>leal Buck<br>bde PWM<br>shaping -<br>ssive<br>bds-boost<br>control-<br>urs 45<br>In Wiley |

| 2               | Simon              | Ang and Alejandro Oliva,                          | "Power Sw     | itching Converte                  | ers", Taylor & Fra          | ncis     |
|-----------------|--------------------|---|---------------|-----------------------------------|-----------------------------|----------|
| 3               | William 2005.      | Shepherd and Li zhang, "                          | Power Con     | verters Circuits"                 | , Marceld Ekker             | in,C,    |
| Reference       | e Books:           |   |               |                                   |                             |          |
| 1               | Marian.<br>Wiley & | K.Kazimierczuk and Dariu<br>Sons limited, 2011    | uszCzarkow    | ∕ski, "Resonant I                 | Power Converter             | rs",John |
| 2               | Abraha<br>Design"  | m I.Pressman, Keith Billin<br>' McGraw-Hill ,2009 | gs and Tay    | lor Morey, " Swi                  | tching Power Su             | pply     |
| 3               | V.Rama<br>Banglor  | anarayanan, "Course Mate<br>e, 2007               | erial on Swi  | tched Mode Pov                    | ver Conversion"             | ISC,     |
| 4               | Christo            | ohe P. Basso, Switch-Mod                          | de Power S    | upplies, McGrav                   | v-Hill ,2014                |          |
| Web Refe        | rences:            |   |               |                                   |                             |          |
| 1.              | http://w           | ww.ee.iisc.ac.in/new/peop                         | ole/faculty/v | john/ref/smpcbo                   | ok,%20VR.pdf                |          |
| 2.              | https://r          | ptel.ac.in/syllabus/10810                         | 4015/         |                                   |                             |          |
| 3.              | https://r          | nptel.ac.in/downloads/108                         | 105066/       |                                   |                             |          |
|                 |                    | Continuous Assessn                                | nent          |                                   |                             |          |
| Forma<br>Assess | ntive<br>ment      | Summative<br>Assessment                           | Total         | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total    |
| 80              |                    | 120   | 200           | 40                                | 60                          | 100      |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy) |  |                        |  |  |  |  |
|-------------------|---|--|------------------------|--|--|--|--|
| Formative         | Assessment ba   | sed on Capstone Model  |                        |  |  |  |  |
| Course<br>Outcome | Bloom's<br>Level  | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |  |
| C505.1            | Apply   | Online Quiz  | 20                     |  |  |  |  |
| C505.2            | Apply   | Class Presentation   | 20                     |  |  |  |  |
| C505.3            | Understand  | Croup Assignment 20  |                        |  |  |  |  |
| C505.4            | Analyze   | Analyze Group Assignment 20  |                        |  |  |  |  |
| C505.5            | Understand  | Simulation Program   | 20                     |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |

| Assessm                           | ent based on (                 | Continuous an                   | d End Sem          | ester Examina                  | ation                           |                         |
|-----------------------------------|--------------------------------|---------------------------------|--------------------|--------------------------------|---------------------------------|-------------------------|
|                                   | (                              | Continuous As<br>[200           | sessment<br>Marks] | (40%)                          |                                 | End                     |
| CA 1 : 100 Marks CA 2 : 100 Marks |                                |                                 |                    |                                |                                 | Semester<br>Examination |
| SA 1                              | FA 1 (40                       | 0 Marks)                        | SA 2               | FA 2 (4                        | 0 Marks)                        | (60%)                   |
| (60<br>Marks)                     | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks)      | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C505.1           | 3       | 1       | 1       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C505.2           | 3       | 2       | 2       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C505.3           | 3       | 2       | 1       |         |         |         |         |         |         |          |          | 3        |          | 2        |          |
| C505.4           | 3       | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| C505.5           | 3       | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | N       | loder   | ately   | Agre    | ed       | 3        | 0,       | Strong   | y Agree  | ed       |

| 22PE506     |   | Systems  | 3/0/0/3    |  |  |  |  |
|-------------|---|--|------------|--|--|--|--|
| Nature of   | Course  | E (Theory skill based)   |            |  |  |  |  |
| Course P    | re-requisites   | Power Electronics, Control Systems   |            |  |  |  |  |
| Course O    | bjectives:  |  |            |  |  |  |  |
| 1           | To expose the devices with s  | e basic theoretical and practical applications of power semi imulation.                | conductor  |  |  |  |  |
| 2           | To develop ba   | sic AC-DC, DC-DC, DC-AC conversion circuit fed drives.                                 |            |  |  |  |  |
| 3           | To develop controllers for power electronics circuits.                          |  |            |  |  |  |  |
| Course Ou   | tcomes:   | •  |            |  |  |  |  |
| Upon com    | pletion of the o  | course, students shall have ability to   |            |  |  |  |  |
| C506.1      | Infer the basic   | applications of various power semiconductor devices.                                   | [U]        |  |  |  |  |
| C506.2      | Analyse and d   | lesign various machine models.   | [A]        |  |  |  |  |
| C506.3      | Apply AC/DC   | rectifier circuits to DC Motors.   | [AP]       |  |  |  |  |
| C506.4      | Design basic a  | and advanced DC/DC converter circuits.   | [AP]       |  |  |  |  |
| C506.5      | Interpret the r   | ole of power electronic systems for improvement of                                     | [U]        |  |  |  |  |
|             | power quality.  |  |            |  |  |  |  |
| C506.6      | Analyse and d   | lesign inverter circuits for control of drives.  | [A]        |  |  |  |  |
| Course C    | ontents:  |  |            |  |  |  |  |
| Module 1    | Modelling of I  | Power Devices  | 15 Hrs     |  |  |  |  |
| Modelling   | of Diodo SCP  | MOSEET ICBT in Simulation Simulation of gato/base driv                                 |            |  |  |  |  |
| Simulation  | of Snubber ci   | rcuit Introduction to electrical machine modelling: Induction                          | DC and     |  |  |  |  |
| Synchrone   | us machines   | real. Introduction to cleaned machine modeling. Induction,                             | DO, and    |  |  |  |  |
| Cynonione   |   |  |            |  |  |  |  |
| Module 2:   | Simulation of   | Rectifier and Chopper fed drives   | 15 Hrs     |  |  |  |  |
| Simulation  | of single and the   | hree phase converters-Uncontrolled. Semi controlled and fully                          |            |  |  |  |  |
| controlled  | converter fed D   | C motor drive. Dual Converter. Simulation of DC-DC converte                            | r fed dc   |  |  |  |  |
| motor drive | es-Buck, Boost,   | , Buck-Boost Converters, Simulation of four quadrant operation                         | ns of DC-  |  |  |  |  |
| DC conver   | ter Simulation  | n of Power factor correction schemes with controllers PWM.                             |            |  |  |  |  |
|             |   |  |            |  |  |  |  |
| Module 3    | Simulation of   | Inverter fed Drives  | 15 Hrs     |  |  |  |  |
| Simulation  | of single an  | d three phase inverters with MOSFET and IGBT, Space                                    | e Vector   |  |  |  |  |
| Represent   | ation, Pulse-wid  | dth modulation methods for voltage and waveform control. Sin                           | ulation of |  |  |  |  |
| Inverter fe | d Induction and   | BLDC motor drives.   |            |  |  |  |  |
|             |   | Total Ho   | urs 45     |  |  |  |  |
| Text Book   | (S:   |  |            |  |  |  |  |
| 1           | Rashid M.H.,  | "Power Electronics Circuits, Devices and Applications", Prentic                        | e Hall     |  |  |  |  |
|             | India,3rd Editi   | ON, NEW DEINI, 2014.<br>   |            |  |  |  |  |
| 2           | Modio Indio   | er., Fundamentals of Power Electronics with MATLAD, Firewa                             | 111        |  |  |  |  |
|             | Dr. Shailandra  | Jain Modelling and Simulation using MATLAR   |            |  |  |  |  |
| 3           | Simulink Wiley  | 2 2ndEdition 2015  |            |  |  |  |  |
|             | Viktor M Pere   | y, 2110Eutition, 2013<br>Multer, "Electrotechnical Systems Simulation with Simulink an | d Sim      |  |  |  |  |
| 4           | Power System  | ns TM <sup>®</sup> CRC Press Taylor and Francis Group 2013                             | u Oim      |  |  |  |  |
| Reference   | Books:  |  |            |  |  |  |  |
| 1           | Ned Mohan T   | ore M. Undeland, William P. Robbins, "Power Electronics                                |            |  |  |  |  |
|             | Converters, Applications, and Design", 3 rd Edition, John Wiley and Sons, 2009. |  |            |  |  |  |  |
| 2           | Haitham Abu-  | Rub., Etal., "High Performance Control of AC Drives                                    |            |  |  |  |  |
|             | withMatlab/Simulink Models". Wiley Publications. 1 <sup>st</sup> Edition. 2012  |  |            |  |  |  |  |
| Web Refe    | rences:   |  |            |  |  |  |  |
| 1.          | https://www.m   | athworks.com/support/books/book54209.html?categorv=1                                   |            |  |  |  |  |
| 2.          | http://nptel.ac.  | in/downloads/108105066/  |            |  |  |  |  |
| 3.          | http://nptel.ac.  | in/courses/108101038/  |            |  |  |  |  |
| 4.          | https://www.co  | oursera.org/specializations/power-electronics  |            |  |  |  |  |
|             |   |  |            |  |  |  |  |

**Digital Control of Power Electronics and Drive** 

22PE506

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy) |  |                        |  |  |  |  |
|-------------------|---|--|------------------------|--|--|--|--|
| Formative         | Assessment ba   | sed on Capstone Model  |                        |  |  |  |  |
| Course<br>Outcome | Bloom's<br>Level  | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |  |
| C506.1            | Understand  | Quiz   | 20                     |  |  |  |  |
| C506.2            | Analyse   | Presentation   | 20                     |  |  |  |  |
| C506.3            | Apply   | Assignment   | 20                     |  |  |  |  |
| C506.4            | Apply   | Assignment   | 20                     |  |  |  |  |
| C506.5            | Understand  | Simulation Brogram 20  |                        |  |  |  |  |
| C506.5            | Analyse   |  | 20                     |  |  |  |  |

| Summative and End Gemester Examination       Summative Assessment (24%)       Bloom's Level     [120 Marks] |                   |                   |             |  |  |  |  |  |  |
|---|-------------------|-------------------|-------------|--|--|--|--|--|--|
|   | CIA1 : [60 Marks] | CIA2 : [60 Marks] | [100 Marks] |  |  |  |  |  |  |
| Remember  | 20                | 20                | 20          |  |  |  |  |  |  |
| Understand  | 20                | 20                | 20          |  |  |  |  |  |  |
| Apply   | 30                | 30                | 30          |  |  |  |  |  |  |
| Analyse   | 30                | 30                | 30          |  |  |  |  |  |  |
| Evaluate  | -                 | -                 | -           |  |  |  |  |  |  |
| Create  | -                 | -                 | -           |  |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |                         |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------------------|--|
|               | End   |                                 |               |                                |                                 |                         |  |
|               | CA 1 : 100 Ma   | arks                            |               | CA 2 : 100 Ma                  | arks                            | Semester<br>Examination |  |
| SA 1          | FA 1 (40  | 0 Marks)                        | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)                   |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | РО<br>6 | PO<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | РО<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C506.1           | 3       | 1       | 1       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C506.2           | 3       | 2       | 2       | 1       |         |         |         |         |         |          |          |          |          | 2        |          |
| C506.3           | 3       | 2       | 1       |         |         |         |         |         |         |          |          | 3        |          | 2        |          |
| C506.4           | 3       | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| C506.5           | 3       | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| C506.6           | 3       | 3       | 3       | 2       |         | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | N       | loder   | ately   | Agre    | ed       | 3        | \$       | Strong   | y Agree  | ed       |

| 22PE507  |  | Special Electrical Machines   | 3/0/0/3   |  |  |  |  |  |
|--|--|---|---|--|--|--|--|--|
| Nature of  | Course D (Theory Application)  |   |   |  |  |  |  |  |
| Course P   | e-requisites   | Electrical Machines   |   |  |  |  |  |  |
| Course O   | bjectives:   |   |   |  |  |  |  |  |
| 1  | To impart knowledge on the performance of Permanent Magnet Brushless DC and Permanent Magnet Synchronous motors                              |   |   |  |  |  |  |  |
| 2  | To realize the switched reluct   | constructional features and control strategies of Synchror ance motor.  | nous and  |  |  |  |  |  |
| 3  | To learn the wo  | rking operation and performance characteristics of Stepping a tance motors.   | and   |  |  |  |  |  |
| 4  | To realize the o   | onstructional features of linear induction and servo motors   |   |  |  |  |  |  |
|  | tcomes:  |   |   |  |  |  |  |  |
| Upon com   | oletion of the co  | ourse students shall have ability to  |   |  |  |  |  |  |
|  | Illustrate the he  | usehold and vehicle annlications of Bruchless DC motor  |   |  |  |  |  |  |
| C507.1   | iniustrate the ho  | Magnet Synchronous meters   | [AP]  |  |  |  |  |  |
| 0507.0   |  | Inagnet Synchronous motors.   |   |  |  |  |  |  |
| 0507.2   | Analyze the per  | rrormance of Switched reluctance motor.   | [A]   |  |  |  |  |  |
| C507.3   | Compare the S<br>motor.  | synchronous reluctance motor and Switched reluctance  | [U]   |  |  |  |  |  |
| C507.4   | Interpret the op<br>motors.  | eration, characteristics and control methods of stepping  | [U]   |  |  |  |  |  |
| C507.5   | Explain the ope<br>Servo motors.   | eration, characteristics of linear induction motor and  | [AP]  |  |  |  |  |  |
| Course C   | ontents:   |   |   |  |  |  |  |  |
| permanen<br>characteri<br><b>Module 2:</b><br>Construction<br>Controllers<br>features of<br>reluctance | t magnet brush<br>stics, power con<br><b>Switched and</b><br>onal features, pri-<br>s, methods of rot<br>synchronous re<br>torque, phasor of | nless motor drives, torque and EMF equation, torque an<br>overters and their controllers applications.<br>Synchronous Reluctance Motors<br>inciple of operation, torque equation, power converters and the<br>for position and sensorless operations, applications, Construct<br>eluctance motor, axial and radial air gap motors, operating pri<br>diagram, motor characteristics, applications. | nd speed<br><b>15 Hrs</b><br>eir<br>tional<br>nciple, |  |  |  |  |  |
| Modulo 2   | Stopping Motor   |   | 15 Uro  |  |  |  |  |  |
| Construction<br>reluctance<br>control, clo<br>operation,   | onal features, pr<br>stepping moto<br>sed loop contro<br>servo motors, Ty  | rinciple of operation, modes of excitation torque production ir<br>r, dynamic characteristics drive systems and circuit for o<br>of of stepping motor, Linear Induction motor, Construction, pr<br>ypes, construction, principle of operation.  | variable<br>pen loop<br>inciple of                    |  |  |  |  |  |
| <b>T</b> ( <b>F</b> )  |  | Total Hou   | urs   45  |  |  |  |  |  |
| Text Book  | (S:  |   |   |  |  |  |  |  |
| 1  | D.P.Kothari and  | d I.J.Nagrath "Electrical machines " Tata McGraw-Hill Education   | on, 2013  |  |  |  |  |  |
| 2  | K. Venkataratn   | am "Special Electric Machines" Universities Press, 2012.  |   |  |  |  |  |  |
| 3  | E.G.Janardhan<br>limited 2015  | an 'Special Electrical Machines' PHI learning private   |   |  |  |  |  |  |
| Reference  | Books:   |   |   |  |  |  |  |  |
| 1  | A. Miller, T.J.E<br>motordrives",C   | . "Brushless permanent magnet and reluctance larendon Press, Oxford, 2012   |   |  |  |  |  |  |
| 2  | B. Kenjo, T, "<br>Press,Oxford 2   | Stepping motors and their microprocessor control", Clarenc 011.   | lon   |  |  |  |  |  |
| 3  | C. R.Krishnan,   | "Switched Reluctance Motors Drives: Modelling, Simulation,  |   |  |  |  |  |  |
|  |  |   |   |  |  |  |  |  |
| R2022  |  | M.E Power Electronics and Drives  | Page 52   |  |  |  |  |  |

|                 | AnalysisDesign and Applications", CRC Press, New York, 2011.               |  |  |  |
|-----------------|--|--|--|--|
| Web References: |  |  |  |  |
| 1.              | https://easyengineering.net/ee6703-special-electrical-machines             |  |  |  |
| 2.              | https://www.ametuniv.ac.in/exam/UG//EE1704-special-electrical-machines.pdf |  |  |  |
| 3.              | https://nptel.ac.in/courses/108105017/2                                    |  |  |  |
| 4.              | https://onlinecourses.nptel.ac.in/noc19_ee01                               |  |  |  |

| Formative<br>Assessment | rmative Summative<br>essment Assessment |     | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|---|-----|-----------------------------------|-----------------------------|-------|
| 80                      | 120                                     | 200 | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |  |              |    |  |  |  |  |
|---|--|--------------|----|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model   |              |    |  |  |  |  |
| Course<br>Outcome                                       | rse Bloom's<br>Deme Level Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) |              |    |  |  |  |  |
| C507.1  | Apply  | Quiz         | 20 |  |  |  |  |
| C507.2  | Analyze  | Presentation | 20 |  |  |  |  |
| C507.3  | Understand   | Assignment   | 20 |  |  |  |  |
| C507.4  | Understand   |              | 20 |  |  |  |  |
| C507.5  | Apply  | Case Study   | 20 |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |  |  |
| Remember   | 20                      | 20                     | 20                                |  |  |  |  |  |
| Understand   | 20                      | 20                     | 20                                |  |  |  |  |  |
| Apply  | 30                      | 30                     | 30                                |  |  |  |  |  |
| Analyse  | 30                      | 30                     | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |  |  |
| Create   | -                       | -                      | -                                 |  |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |                       |                                |                                 |                         |  |  |
|---|--------------------------------|---------------------------------|-----------------------|--------------------------------|---------------------------------|-------------------------|--|--|
|   | End                            |                                 |                       |                                |                                 |                         |  |  |
| CA 1 : 100 Marks CA 2 : 100 Marks                           |                                |                                 |                       |                                | arks                            | Semester<br>Examination |  |  |
| SA 1  | FA 1 (40 Marks)                |                                 | SA 2                  | FA 2 (40 Marks)                |                                 | (60%)                   |  |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | SA 2<br>(60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | PO<br>4           | PO<br>5 | PO<br>6 | РО<br>7         | PO<br>8 | РО<br>9 | РО<br>10 | РО<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|-------------------|---------|---------|-----------------|---------|---------|----------|----------|----------|----------|----------|----------|
| C507.1           | 3                 | 1       | 1       | 1                 |         |         |                 |         |         |          |          |          |          | 2        |          |
| C507.2           | 3                 | 2       | 2       | 1                 |         |         |                 |         |         |          |          |          |          | 2        |          |
| C507.3           | 3                 | 2       | 1       |                   |         |         |                 |         |         |          |          | 3        |          | 2        |          |
| C507.4           | 3                 | 3       | 3       | 2                 |         | 1       | 1               |         |         |          |          | 2        |          | 3        |          |
| C507.5           | 3                 | 3       | 3       | 2                 |         | 1       | 1               |         |         |          |          | 2        |          | 3        |          |
| 1                | Reasonably Agreed |         | 2       | Moderately Agreed |         | 3       | Strongly Agreed |         | ed      |          |          |          |          |          |          |

| 22PE508   | Power System Restructuring and Deregulation  |  |   |  |  |  |  |  |
|---|--|--|---|--|--|--|--|--|
| Nature of   | Course   | D (Theory Application)   |   |  |  |  |  |  |
| Course P  | re-requisites  | Nil  |   |  |  |  |  |  |
| Course O  | bjectives:   |  |   |  |  |  |  |  |
| 1   | To provide in-<br>systems.   | depth understanding of operation of deregulated electricity man  | <sup>-</sup> ket  |  |  |  |  |  |
| 2   | To examine ty world-wide in  | pical issues in electricity markets and how these are handled various markets.   |   |  |  |  |  |  |
| 3   | To enable stue<br>control issues   | dents to analyze various types of electricity market operational using new mathematical models.  | and   |  |  |  |  |  |
| Course Ou<br>Upon com   | tcomes:<br>pletion of the c  | course, students shall have ability to   |   |  |  |  |  |  |
| C508.1  | Interpret the o  | peration of deregulated electricity market systems   | [U]   |  |  |  |  |  |
| C508.2  | Examine the v<br>issues using n  | various types of electricity market operational and control new mathematical models.   | [A]   |  |  |  |  |  |
| C508.3  | Collect the va   | rious issues in deregulation management  | [AP]  |  |  |  |  |  |
| C508.4  | Develop the in   | terruption methods and models of power system deregulation   | [AP]  |  |  |  |  |  |
| C508.5  | Analyze the re   | liability and regulation of the restricted power   | [A]   |  |  |  |  |  |
| Course C  | ontents:   |  |   |  |  |  |  |  |
| Module 1:<br>Deregulati<br>deregulation<br>market aft<br>planning a | <b>Overview of E</b><br>on, Reconfigur<br>on and the curr<br>ter effects of o<br>activities of ISO           | Deregulation<br>ing Power systems, unbundling of electric utilities, Backg<br>rent situation around the world, benefits from a competitive<br>deregulation. Role of the independent system operator, Operational<br>: ISO in Pool markets, ISO in Bilateral markets, Operational | <b>15 Hrs</b><br>pround to<br>electricity<br>perational<br>planning |  |  |  |  |  |
| activities competitive  | activities of a GENCO: Genco in Pool and Bilateral markets, market participation issues, competitive bidding |  |   |  |  |  |  |  |

#### Module 2: Deregulation Management

Power wheeling, Transmission open access, pricing of power transactions, security management in deregulated environment, and congestion management in deregulation. General description of some ancillary services, ancillary services management in various countries, and reactive power management in some deregulated electricity markets.

#### Module 3 Interruption and Reliability Analysis

Interruption criterion, stochastic components, component models, Calculation methods, Network model: stochastic networks, series and parallel connections, minimum cut sets, reliability cost. Generation, transmission and distribution reliability, Reliability and deregulation: conflict, reliability analysis, effects on the actual reliability, regulation of the market.

|           | Total Hours   45  |
|-----------|---|
| Text Book | (S:   |
| 1         | K. Bhattacharya, MHT Bollen and J.C Doolder, "Operation of Restructured Power Systems", Kluwer Academic Publishers, USA, 2010.                    |
| 2         | Lei Lee Lai, "Power System restructuring and deregulation", John Wiley and Sons, UK. 2013.  |
| 3         | Electrical Power Systems: Analysis, Security and Deregulation Second Edition P.Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, 2017.  |
| Reference | e Books:  |
| 1         | Mohammad Shahidehpour and Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker Pub, 2013. |
| 2         | Steven Stoft, "Power system economics: designing markets for electricity", John Wiley & Sons, 2011.   |
| 3         | Fred I Denny and David E. Dismukes, "Power System Operations and Electricity Markets", CRC Press, LLC, 2012.                                      |
| Web Refe  | rences:   |
| 1.        | http://www.iexindia.com/  |
| 2.        | http://www.powerexindia.com/  |
|           |   |

# 15 Hrs

15 Hrs

| 3. | http://www.cercind.gov.in/ |
|----|----------------------------|
| 4. | http://www.iexindia.com/   |

| Formative<br>Assessment | Summative<br>Assessment | Total<br>Total Continuous<br>Assessment |    | End Semester<br>Examination | Total |
|-------------------------|-------------------------|---|----|-----------------------------|-------|
| 80                      | 120                     | 200                                     | 40 | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |  |  |                        |  |  |  |  |
|---|--|--|------------------------|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model |  |                        |  |  |  |  |
| Course<br>Outcome                                       | Bloom's<br>Level                             | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |  |
| C508.1  | Understand                                   | Quiz   | 20                     |  |  |  |  |
| C508.2  | Analyze                                      | Presentation   | 20                     |  |  |  |  |
| C508.3  | Apply  | Assignment   | 20                     |  |  |  |  |
| C508.4  | Apply  |  | 20                     |  |  |  |  |
| C508.5  | Analyze                                      | Case Study   | 20                     |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |  |  |
| Remember   | 10                      | 10                     | 10                                |  |  |  |  |  |
| Understand   | 20                      | 20                     | 20                                |  |  |  |  |  |
| Apply  | 40                      | 40                     | 40                                |  |  |  |  |  |
| Analyse  | 30                      | 30                     | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |  |  |
| Create   | -                       | -                      | -                                 |  |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |                       |                                |                                 |                         |  |  |
|---|--------------------------------|---------------------------------|-----------------------|--------------------------------|---------------------------------|-------------------------|--|--|
|   | End                            |                                 |                       |                                |                                 |                         |  |  |
|   | CA 1 : 100 Ma                  | arks                            | CA 2 : 100 Marks      |                                |                                 | Semester<br>Examination |  |  |
| SA 1  | FA 1 (40 Marks)                |                                 | SA 2                  | FA 2 (40 Marks)                |                                 | (60%)                   |  |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | SA 2<br>(60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |  |

| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | PO<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C508.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C508.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C508.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C508.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C508.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | 3       | 9,       | Strong   | y Agree  | ed       |          |          |

| Course O   | bjectives:  |  |
|--|---|--|
| 1  | To study about different approaches and design of VAR Controllers   |  |
| 2  | To impart the knowledge on various harmonics  |  |
| 3  | To understand the concept of Filtering system in harmonics  |  |
| 4  | To expose the ideas about recent trends in Static VAR Controllers optimization<br>problems  | n  |
| Course Ou  | itcomes:  |  |
| Upon com   | pletion of the course, students shall have ability to   |  |
| C509.1   | Analyze the concepts of various Harmonics system in the distributed system  | [A]  |
| C509.2   | Interpret the concepts of compensation schemes  | [U]  |
| C509.3   | Apply optimization schemes in Static VAR Controllers  | [AP]   |
| C509.4   | Analyze the performance of Filtering Circuit in Harmonics Control   | [A]  |
| Course C   | ontents:  |  |
| Module 1<br>Power Qu<br>harmonics  | <b>: Fundamentals of Load Compensators</b><br>ality Issues - Sources of Harmonics in Distribution Systems and impact of thi<br>s. Static Reactive Power Compensatorsand their control.  | <b>15 Hrs</b><br>rd order                                      |
| Module 2<br>Shunt Co<br>Controlled<br>Thyristor,<br>Resonand<br>Static Cor | <b>Compensation Scheme</b><br>Impensators, Static VAR Compensators(SVC) of Thyristor Switched and T<br>I types, control modes, STATCOMs and their control, Series Compensa<br>Static Shunt Series Compensator(SSSC) and its Control, Sub- Sync<br>ice- Transient and Dynamic Stability Improvement in Power Systems - Conve<br>mpensation.                            | <b>15 Hrs</b><br>Thyristor<br>ators of<br>hronous<br>rters for |
| Gate Turi<br>Harmonic<br>their cont<br>Cancellati<br>Restorer a            | n ON/OFF(GTO) Inverters, Multi-Level Inverters for Static VAR Controllers-<br>Filtering. Single Phase Shunt Filter and its Control, Three Phase Active Filter<br>rol Hybrid Filtering using Shunt Active Filters, Series Active Filtering in H<br>on Mode. Series Active Filtering in Harmonic Isolation Mode, Dynamic<br>and its control. Power Quality Conditioner. | Passive<br>ring and<br>armonic<br>Voltage                      |
| <b>T</b> ( <b>D</b>  | Total Hou   | rs 45  |
| Text Boo   | KS:   |  |
| 1  | Narain G. Hingorani and Laszlo GyugyiN.G. Hingorani and L. Gyugyi IEEE Pre<br>Narain G.Hingorani and Laszlo Gyugyi" Understanding FACTS-Concepts and<br>Technology of Flexible AC Transmission Systems", Standard Publishers, New<br>2015.  | Delhi,   |
| 2  | Farhad Shahnia, Sumedha Rajakaruna, Arindam Ghosh "Static Compensa (STATCOMs) in Power Systems"Springer Singapore, 2014   | ators  |
| 3  | Xiao-Ping Zhang "Flexible AC Transmission Systems" Springer ,2010   |  |
|  | K.R. Padiyar, "FACTS Controllers for Power Transmission and Distribution" Ne  | W  |
|  | Age International Publishers, 2016  |  |
| Referenc   |   |  |
| 1  | Edition.2006  |  |
| 2  | Robert Diffenderfer, 'Electronic Devices: Systems and Applications', Cengage Learning, 2010   |  |
| 3  | K.R. Padiyar, "FACTS Controllers for Power Transmission and Distribution" Net Age International Publishers, 2016  | W  |
| Web Refe   | erences:  |  |
| 1.   | http://nptel.ac.in/courses/108104052/1  |  |
| D2022  | M.E., Douvou Electronics and Drives   |  |

Static VAR Controllers and Harmonic Filtering

G (Theory) Power Electronics

22PE509

Nature of Course **Course Pre-requisites** 

| 2. | https://nptel.ac.in/syllabus/syllabus.php?subjectId=108104014                    |
|----|--|
| 3. | https://www.edx.org/course/smart-grids- electricity-future- ieee-smart grid- x-0 |
| 4. | https://www.energy.siemens.com/nl/en/power-transmission/facts/static-var-        |
|    | compensator- plus/references.htm   |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy)  |                      |    |  |  |  |
|-------------------|--|----------------------|----|--|--|--|
| Formative         | Assessment base  | ed on Capstone Model |    |  |  |  |
| Course<br>Outcome | Course<br>OutcomeBloom's LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%)<br> |                      |    |  |  |  |
| C509.1            | Analyze  | Online Quiz          | 20 |  |  |  |
| C509.2            | Understand Class Presentation 20   |                      |    |  |  |  |
| C509.3            | 9.3 Apply Group Assignment 20  |                      |    |  |  |  |
| C509.4            | C509.4 analyse Case study 20   |                      |    |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |               |                                |                                 |                         |
|---|--------------------------------|---------------------------------|---------------|--------------------------------|---------------------------------|-------------------------|
|   | End                            |                                 |               |                                |                                 |                         |
|   | CA 1 : 100 Ma                  | arks                            |               | CA 2 : 100 Ma                  | arks                            | Semester<br>Examination |
| SA 1  | FA 1 (4                        | 0 Marks)                        | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)                   |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |

| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | PO<br>6           | PO<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C509.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C509.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C509.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C509.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonab   | oly Ag  | greed   | 2       | Moderately Agreed |         |         |         | 3        | °,       | Strong   | y Agree  | ed       |          |

| 22PB516   |  | Optimization Techniques  | 3/0/0/3  |  |  |  |  |  |  |
|---|--|--|--|--|--|--|--|--|--|
| Nature of   | f Course   | F (Theory Programming)   |  |  |  |  |  |  |  |
| Course F  | Course Pre-requisites NIL  |  |  |  |  |  |  |  |  |
| Course C  | Course Objectives:   |  |  |  |  |  |  |  |  |
| 1   | 1 To introduce the basic concepts of linear programming  |  |  |  |  |  |  |  |  |
| 2   | 2 To educate on the advancements in Linear programming techniques  |  |  |  |  |  |  |  |  |
| 3   | To introduce the   | he interior point methods of solving problems  |  |  |  |  |  |  |  |
| 4   | To introduce the   | he dynamic programming method  |  |  |  |  |  |  |  |
| Course C  | Dutcomes:  | e course, students shall have ability to   |  |  |  |  |  |  |  |
| C516 1  | Infer important  | ce of optimization in process management   | [[]]   |  |  |  |  |  |  |
| 0010.1  | Apply basic c  | concepts of mathematics to formulate an optimization   |  |  |  |  |  |  |  |
| C516.2  | problem  |  | [AP]   |  |  |  |  |  |  |
| C516.3  | Interpret the lin  | near and nonlinear programming in optimization techniques.   | [U]  |  |  |  |  |  |  |
| C516.4  | Analyze about<br>optimization al   | t computational complexity and performance metrics of various lgorithms.   | [A]  |  |  |  |  |  |  |
| C516.5  | Analyze the d strategy.  | lifferent optimization methods based on requirements and   | [A]  |  |  |  |  |  |  |
| C516.6  | Analyse and a optimization pr  | appreciate variety of performance measures for various roblems   | [A]  |  |  |  |  |  |  |
| Course C  | Contents:  |  |  |  |  |  |  |  |  |
| simplex a<br>analysis -<br>Envelopm<br><b>Module 2</b><br>Classifica<br>conditions    | Igorithm - Revi<br>Transportation<br>nentAnalysis.<br>2: Non Linear P<br>tion of Non Lin<br>s - Reduced gra  | ised Simplex Method. Dualit theory - Dual simplex method - S<br>problems - Assignment problems -Traveling sales man proble<br><b>Programming</b><br>lear programming - Lagrange multiplier method - Karush - Kuhi<br>adient algorithms - Quadratic programming method - Penalty an | ensitivity<br>em -Data<br><b>15 Hrs</b><br>n Tucker<br>d Barrier |  |  |  |  |  |  |
| Method.<br>Module 3<br>Karmarka<br>Barrier alg<br>sub-optim<br>and Forw<br>value prol | Module 3: Interior Point Methods and Dynamic Programming15 HrsKarmarkar's algorithm–Projection Scaling method–Dual affine algorithm–Primal affine algorithm15 HrsBarrier algorithm. Formulation of Multi stage decision problem–Characteristics –Concept of<br>sub-optimization and he principle of optimality-Formulation of Dynamic programming-Backward<br>and Forward recursion-Computational procedure–Conversion offinal value problem in to Initial<br>value problem. |  |  |  |  |  |  |  |  |
| Text Boo  | ke   |  | 115 4J   |  |  |  |  |  |  |
| 1   | Hillier and Lieb   | perman "Introduction to Operations Research". TMH. 2000.   |  |  |  |  |  |  |  |
| 2   | R.Panneerselv  | /am, "Operations Research", PHI, 2006  |  |  |  |  |  |  |  |
| 3   | 3 Hamdy ATaha, "Operations Research – An Introduction", Prentice Hall India, 2003.   |  |  |  |  |  |  |  |  |
| Reference   | e Books:   |  |  |  |  |  |  |  |  |
| 1   | Philips, Ravino  | dran and Solberg, "Operations Research", John Wiley, 2002.   |  |  |  |  |  |  |  |
| 2   | Donald L.Raro<br>New Delhi, 20   | din, "Optimization in Operation Research" Pearson Education Pv<br>05.  | /t.Ltd.  |  |  |  |  |  |  |
| Web Ref   | erences:   |  |  |  |  |  |  |  |  |
| 1   | https://online.s   | stanford.edu/courses/mse211-introduction-optimization  |  |  |  |  |  |  |  |
| 2   | https://nptel.ac   | c.in/courses/111105039/  |  |  |  |  |  |  |  |
| 3   | https://www.m  | ooc-list.com/tags/optimization-methods   |  |  |  |  |  |  |  |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy)   |                       |    |  |  |  |  |
|-------------------|---|-----------------------|----|--|--|--|--|
| Formative         | Assessment ba   | sed on Capstone Model |    |  |  |  |  |
| Course<br>Outcome | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                       |    |  |  |  |  |
| C516.1            | Understand  | Quiz                  | 20 |  |  |  |  |
| C516.2            | Apply   | Class Presentation    | 20 |  |  |  |  |
| C516.3            | Analyze Assignment 20   |                       |    |  |  |  |  |
| C516.4            | C516.4 Analyze Assignment 20  |                       |    |  |  |  |  |
| C516.5            | C516.5 Analyze Case Study 20  |                       |    |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |          |      |         |          |       |  |  |  |
|---------------|---|----------|------|---------|----------|-------|--|--|--|
|               | End   |          |      |         |          |       |  |  |  |
|               | Semester<br>Examination                                     |          |      |         |          |       |  |  |  |
| SA 1          | FA 1 (40  | 0 Marks) | SA 2 | FA 2 (4 | 0 Marks) | (60%) |  |  |  |
| (60<br>Marks) | [100 Marks]   |          |      |         |          |       |  |  |  |

| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | РО<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C516.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C516.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C516.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C516.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C516.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C516.6           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | 3       | \$       | Strong   | y Agree  | ed       |          |          |

| 22PE510   | Pov   | ver Electronics for Renewable Energy Systems                                    | 3/0/0/3    |  |  |  |
|-----------|---|---|------------|--|--|--|
| Nature of | Course  | D (Theory Application)  |            |  |  |  |
| Course P  | re-requisites   | Power Electronics   |            |  |  |  |
| Course O  | bjectives:  |   |            |  |  |  |
| 1         | To provide kno  | owledge about different types of renewable energy systems.                      |            |  |  |  |
| 2         | To analyze the Systems.                                       | e various electrical Generators used for the Wind Energy Conv                   | rsion      |  |  |  |
| 3         | To design a po<br>DC, and AC-A                                | ower converter used in renewable energy systems such as AC C converters.        | -DC, DC-   |  |  |  |
| 4         | To understand renewable ene                                   | I the importance of standalone, grid connected, and hybrid ope<br>ergy systems. | eration in |  |  |  |
| 5         | 5 To analyze various maximum power point tracking algorithms. |   |            |  |  |  |
| Course Ou | Itcomes:  | course, students shall have ability to  |            |  |  |  |
| opon com  | Analyze the in  | practs of renewable energy technologies on the environment                      |            |  |  |  |
| C510.1    | and demonstra   | ate them to harness electrical power.   | [A]        |  |  |  |
| C510.2    | Select a suitat   | ble Electrical machine for Wind Energy Conversion Systems.                      | [U]        |  |  |  |
| C510.3    | Design the por<br>converters for                              | wer converters such as AC-DC, DC-DC, and AC-AC Solar energy systems.            | [AP]       |  |  |  |
| C510.4    | Design the por<br>converters for                              | wer converters such as AC-DC, DC-DC, and AC-AC Wind energy systems.             | [AP]       |  |  |  |
| C510.5    | Interpret the sistems with I                                  | tand-alone, grid-connected, and hybrid renewable energy MPPT.                   | [A]        |  |  |  |
| Course C  | ontents:  |   |            |  |  |  |
|           |   |   |            |  |  |  |

Module 1: Electrical Machines for Wind Energy Conversion Systems (WECS)15 HrsIntroduction to renewable Energy systems - Review of reference theory fundamentals -<br/>Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG),<br/>Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

Module 2: Power Converters and Analysis of Solar PV and Wind Systems 15 Hrs Power Converters solar PV systems: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues. **Power Converters for WECS:** Threephase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter. Analysis: Stand-alone operation of fixed and variable speed WECS-Grid integrated SCIG and PMSG based WECS.

## Module 3 Hybrid Renewable Energy Systems

15 Hrs

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind - PV, Microhydel - PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

| Taxt Books:   |       |
|---|-------|
| Text Books.   |       |
| B.H.Khan "Non-conventional Energy sources ",Tata McGraw-hill Publishing Com     | bany, |
| New Delhi, 2017.  |       |
| S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford Univers  | ty    |
| <sup>2</sup> Press, 2009  |       |
| 3 Rai. G.D, "Non-conventional energy sources", Khanna publishers, 2010.         |       |
| Reference Books:  |       |
| 1 Rashid .M. H "Power electronics Hand book", Academic press,2nd Edition, 2006. |       |
| 2 Rai. G.D," Solar Energy Utilization", Khanna publishers, 5th Edition, 2008.   |       |
| 3 Gray, L. Johnson, "Wind Energy Systems", prentice hall of india, 1995.        |       |

| Web Refe | Web References:  |  |  |  |  |  |  |
|----------|--|--|--|--|--|--|--|
| 1.       | http://unfccc.int/kyoto_protocol/items/2830.php          |  |  |  |  |  |  |
| 2.       | https://www.coursera.org/learn/wind-energy               |  |  |  |  |  |  |
| 3.       | https://www.edx.org/course/solar-energy-delftx-et3034x-0 |  |  |  |  |  |  |

|                         | Continuous Assessment   |       |                                   |                             |       |  |  |  |  |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|--|--|--|--|
| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |  |  |  |  |
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |  |  |  |  |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy)   |                    |    |  |  |  |  |  |  |
|-------------------|---|--------------------|----|--|--|--|--|--|--|
| Formative         | Formative Assessment based on Capstone Model  |                    |    |  |  |  |  |  |  |
| Course<br>Outcome | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                    |    |  |  |  |  |  |  |
| C510.1            | Analyze   | Online Quiz        | 20 |  |  |  |  |  |  |
| C510.2            | Understand  | Class Presentation | 20 |  |  |  |  |  |  |
| C510.3            | Apply   | Assignment         | 20 |  |  |  |  |  |  |
| C510.4            | C510.4 Apply Assignment 20  |                    |    |  |  |  |  |  |  |
| C510.5            | Analyze   | Case Study         | 20 |  |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |  |  |
| Remember   | 20                      | 20                     | 20                                |  |  |  |  |  |
| Understand   | 20                      | 20                     | 20                                |  |  |  |  |  |
| Apply  | 30                      | 30                     | 30                                |  |  |  |  |  |
| Analyse  | 30                      | 30                     | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |  |  |
| Create   | -                       | -                      | -                                 |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |  |  |  |  |  |  |  |  |
|---------------|---|--|--|--|--|--|--|--|--|
|               | End   |  |  |  |  |  |  |  |  |
|               | Semester<br>Examination                                     |  |  |  |  |  |  |  |  |
| SA 1          | SA 1 FA 1 (40 Marks) SA 2 FA 2 (40 Marks)                   |  |  |  |  |  |  |  |  |
| (60<br>Marks) | [100 Marks]   |  |  |  |  |  |  |  |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | РО<br>4 | PO<br>5 | PO<br>6           | PO<br>7 | PO<br>8 | PO<br>9 | РО<br>10 | РО<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C510.1           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C510.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C510.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C510.4           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C510.5           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | 3       |          | Strong   | y Agree  | ed       |          |          |

| 22PE511   |   | MEMS Design: Sensors and Actuators  | 3/0/0/3   |  |  |  |  |
|---|---|---|---|--|--|--|--|
| Nature of   | Course  | D (Theory Application)  |   |  |  |  |  |
| Course P  | re-requisites   |   |   |  |  |  |  |
| Course O  | bjectives:  |   |   |  |  |  |  |
| 1   | To analyze the  | e properties of materials, microstructure and fabrication metho   | ds.   |  |  |  |  |
| 2   | To design and   | I modeling of Electrostatic sensors and actuators.  |   |  |  |  |  |
| 2   | To teach the  | characterizing thermal sensors and actuators through de-  | sign and  |  |  |  |  |
| 3   | modeling.   |   |   |  |  |  |  |
| 4   | To understan  | d the fundamentals of piezoelectric sensors and actuators<br>fferent MEMS and NEMS devices  | through   |  |  |  |  |
| Course Ou   | tcomes:   |   |   |  |  |  |  |
| Upon com  | pletion of the c  | ourse, students shall have ability to   |   |  |  |  |  |
| C511.1  | Analyse the lease sensors & actu  | arning process to design of micro sensors, embedded<br>uators   | [A]   |  |  |  |  |
| C511.2  | Analyse the el  | ectrostatic sensors and actuators through MEMS and NEMS   | [A]   |  |  |  |  |
| C511.3  | Analyse the th devices  | ermal sensors and actuators through MEMS and NEMS   | [A]   |  |  |  |  |
| C511.4  | Analyse the pi  | ezoelectric sensors and actuators through MEMS and NEMS   | [A]   |  |  |  |  |
| C511.5  | Design of piezoresistive sensors for biomedical and micro fluidic<br>applications [AP]  |   |   |  |  |  |  |
| Course C  | ontents:  |   |   |  |  |  |  |
| Overview<br>Conductiv<br>bending a<br><b>Module 2:</b><br>Principle, r<br>actuators-,<br>bimorph se | of micro fabrica<br>ity of semicond<br>nalysis- torsiona<br><b>Electrostatic S</b><br>material, design<br>Applications-Pri<br>ensors, thermal | Auton-Silicon and other material based fabrication processes –<br>luctors-Crystal planes and orientation-stress and strain- flexu<br>al deflections-Intrinsic stress- resonant frequency and quality fa<br><b>Sensors, Thermal Sensing And Actuation</b><br>and fabrication of parallel plate capacitors as electrostatic sen<br>nciple, material, design and fabrication of thermal couples<br>resistor sensors-Applications | Concepts:<br>iral beam<br>actor.<br><b>15 Hrs</b><br>nsors and<br>, thermal |  |  |  |  |
| Module 3:<br>Piezoelect<br>Application<br>application   | Piezoelectric<br>ric effect-cantile<br>ns. Piezoresistin<br>ns,Optical MEM  | <b>Sensing And Actuation</b><br>ever piezo electric actuator model-properties of piezoelectric<br>ve sensors, Magnetic actuation, Micro fluidics applications<br>SNEMS Devices  | <b>15 Hrs</b><br>materials<br>, Medical                                     |  |  |  |  |
|   |   | Total Ho  | urs 45  |  |  |  |  |
| Text Bool   | (S:   |   |   |  |  |  |  |
| 1   | Chang Liu, "Fo  | oundations of MEMS", Pearson International Edition, 2006.   |   |  |  |  |  |
| 2   | Marc Madou ,  | "Fundamentals of microfabrication",CRC Press, 2015  |   |  |  |  |  |
| Reference   | Books:  |   | 0   |  |  |  |  |
| 1   |   | romachined Transducers Source Dook", WCB McGraw Hill, 199   | JØ<br>and   |  |  |  |  |
| 2   | 2 M.H.Bao "Micromechanical transducers: Pressure sensors, accelerometers and  |   |   |  |  |  |  |
| Web Pofo  | rences.   |   |   |  |  |  |  |
|   | https://www.bc  | osch-sensortec.com/   |   |  |  |  |  |
| 1.  | http://www.bc   | ortcoursesportal com  |   |  |  |  |  |
| Ζ.  | <u>11110.// www.5110</u>  |   |   |  |  |  |  |

|                         | Continuous Assessment   |       |                                   |                             |       |  |  |  |  |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|--|--|--|--|
| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |  |  |  |  |
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |  |  |  |  |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |   |                       |    |  |  |  |  |  |
|---|---|-----------------------|----|--|--|--|--|--|
| Formative   | Assessment ba   | sed on Capstone Model |    |  |  |  |  |  |
| Course<br>Outcome                                       | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                       |    |  |  |  |  |  |
| C511.1  | Analyze   | Quiz                  | 20 |  |  |  |  |  |
| C511.2  | Analyze   | Presentation          | 20 |  |  |  |  |  |
| C511.3  | Analyze   | Analyze Assignment 20 |    |  |  |  |  |  |
| C511.4  | Analyze   | Assignment 20         |    |  |  |  |  |  |
| C511.5  | Apply   | Case Study            | 20 |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |               |                                |                                 |             |  |
|---|--------------------------------|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|
|   | End<br>Semester<br>Examination |                                 |               |                                |                                 |             |  |
| CA 1 : 100 Marks CA 2 : 100 Marks                           |                                |                                 |               |                                |                                 |             |  |
| SA 1  | FA 1 (4                        | 0 Marks)                        | SA 2          | FA 2 (4                        | 0 Marks)                        | (60%)       |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | РО<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C511.1           | 3                 | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C511.2           | 3                 | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C511.3           | 3                 | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C511.4           | 3                 | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C511.5           | 3                 | 3       | 1       | 1       |         |         |         |         |         | 1        |          | 2        | 3        |          |          |
| 1                | Reasonably Agreed |         |         | greed   | 2       | Ν       | loder   | ately   | Agre    | ed       | 3        |          | Strong   | y Agree  | ed       |

| 22PE512          | 2 Electrical Systems In Wind Energy 3/0/                                |  |          |  |  |  |
|------------------|---|--|----------|--|--|--|
| Nature of        | Course  | Descriptive  |          |  |  |  |
| Course P         | re-requisites   | Electrical machines  |          |  |  |  |
| Course O         | bjectives:  |  |          |  |  |  |
| 1                | To understan  | d the role of various electrical generators and appropriate power  |          |  |  |  |
| 1                | electronic cor  | ntrollers employed in wind energy conversion systems.              |          |  |  |  |
| 2                | To understan  | d the factors involved in installation and commissioning of a Wind | d plant. |  |  |  |
| 3                | To Learn the  | dynamics involved in grid connected system.                        |          |  |  |  |
| Course O         | utcomes:  |  |          |  |  |  |
| Upon con         | npletion of the   | e course, students shall have ability to                           |          |  |  |  |
| C512 1           | Understand the importance of energy growth of the power generation from |  |          |  |  |  |
| 0312.1           | the renewabl  | e energy sources and participate in solving these problems.        | [0]      |  |  |  |
| C512.2           | Analyse the t   | ypes of wind turbines.   | [A]      |  |  |  |
| C512.3           | Acquire the k   | nowledge in various generator models.                              | [A]      |  |  |  |
| C512 4           | Design and ir   | nplement the suitable closed-loop controller for specific          |          |  |  |  |
| 0012.4           | applications [71]   |  |          |  |  |  |
| C512.5           | Examine the   | concepts in grid connected system.                                 | [A]      |  |  |  |
| Course Contents: |   |  |          |  |  |  |
| Module 1         | Module 1: Introduction of WECS 15 Hrs                                   |  |          |  |  |  |

## Module 1: Introduction of WECS

Principle of operation-Components of WECS - WECS schemes - Power obtained from wind -Power coefficient- Sabinin's theory- Aerodynamics of Wind turbine. HAWT and VAWT- Horizontal Axis Wind Turbine - Vertical Axis Wind Turbine - Power developed- Thrust-Efficiency - Rotor selection- Rotor design consideration- Tip speed ratio - No. of Blades-Blade profile- Power Regulation - Yaw Control-Pitch angle control- Stall control - Schemes for maximum power extraction.

## Module 2: Generating Models in WECS

Fixed Speed Systems- Generating Systems- Constant speed constant frequency systems- Choice of Generators-Deciding Factors-Synchronous Generator-Squirrel Cage Induction Generator -Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis. Variable Speed Systems- Need of variable speed systems -Power-wind speed characteristics - Variable speed constant frequency systems synchronous generator- steady state equivalent circuit- performance analysis of DFIG and PMSG- Variable speed generators modelling.

## Module 3: Grid Connected Systems

Standalone WECS system - Grid Connected WECS system - Grid connection Issues - Machine side controller - Grid side controllers - WECS in various countries - DFIG for standalone applications- operation of DFIGs and PMSGs with different power electronic configurations for standalone and grid connected operation.

| Text Boo | ks:  |
|----------|--|
| 1        | Hau, Erich, "Wind Turbines Fundamentals, Technologies, Application, Economics",  |
| I        | Springer Publications, Third Edition, 2013.                                      |
| 2        | Alois Schaffarczyk, "Understanding Wind Power Technology: Theory, Deployment and |
| Z        | Optimization", Wiley Publications, 2014.   |
| З        | Siegfried Heier, Rachel Waddington, 'Grid Integration of Wind Energy Conversion  |
| 5        | Systems, 2nd Edition', Wiley, June 2006.   |
| Referenc | e Books:   |
| 1        | Gasch, Robert, Twele, Jochen, "Wind Power Plants- Fundamentals, Design,          |
|          | Construction and Operation", Springer Publications, Second Edition, 2012.        |
| 2        | Tony Burton, Nick Jenkins, David Sharpe, Ervin Bossanyi, "Wind Energy            |
|          | Handbook",John Wiley & Sons, Ltd, Second Edition, 2011.                          |

## 15 Hrs

15 Hrs

Total Hours 45

| 3       | Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro, "Power Conversion and Control of |
|---------|--|
|         | Wind Energy System", Wiley Publications, 2011.                                       |
| Web Ref | erences:   |
| 1       | https://www.ee.iitb.ac.in/~npsc2008/NPSC_CD/Data/Tutorial%202/Wind%20Energy%2        |
|         | 0Conversion%20Systems%20-%20Prof.%20S.B.%20Kedare.pdf                                |
| 2       | http://www.windenergy.nref.in  |
| 3       | https://teachergeek.org/wind_turbine_types.pdf                                       |
| 4       | http://www.alternative-energy-tutorials.com/wind-energy/wind-turbine-generator.html  |
| 5       | http://www.wvcommerce.org/App_Media/assets/pdf/energy/WWG/101910Fuller.pdf           |
| 6       | https://www.energy.gov/energysaver/save-electricity-and-fuel/buying-and-             |
|         | makingelectricity/small-wind-electric-systems  |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |                  |  |                        |  |  |
|---|------------------|--|------------------------|--|--|
| Formative   | Assessment ba    | sed on Capstone Model  |                        |  |  |
| Course<br>Outcome                                       | Bloom's<br>Level | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |
| C512.1  | Understand       | Quiz   | 20                     |  |  |
| C512.2  | Analyse          | Presentation   | 20                     |  |  |
| C512.3  | Analyse          | Assignment   | 20                     |  |  |
| C512.4  | Apply            | Assignment   | 20                     |  |  |
| C512.5  | Analyse          | Case Study   | 20                     |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |
| Remember   | 10                      | 10                      | 10                                |  |  |  |  |
| Understand   | 40                      | 20                      | 40                                |  |  |  |  |
| Apply  | 10                      | 20                      | 10                                |  |  |  |  |
| Analyse  | 40                      | 50                      | 40                                |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |               |                                |                                 |                      |  |
|---|--------------------------------|---------------------------------|---------------|--------------------------------|---------------------------------|----------------------|--|
|   | End<br>Semester                |                                 |               |                                |                                 |                      |  |
| CA 1 : 100 Marks CA 2 : 100 Marks                           |                                |                                 |               |                                |                                 |                      |  |
| SΔ 1  | FA 1 (4                        | FA 1 (40 Marks)                 |               | FA 2 (40 Marks)                |                                 | Examination          |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | (00%)<br>[100 Marks] |  |
| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | PO<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C512.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C512.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C512.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C512.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C512.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Rea     | sonab   | oly Ag  | reed    | 2       | Moderately Agreed |         |         | 3       |          | Strongl  | y Agree  | d        |          |          |

| Nature o   | f Course   | D (Theory Application)  |   |
|--|--|---|---|
| Course F   | Pre-requisites   | Nil   |   |
| Course (   | Dbjectives:  |   |   |
| 1  | To impart know   | wiedge of fuzzy sets, relations and fuzzy arithmetic.   |   |
| 2  | To understand  | fuzzification and defuzzification techniques.   |   |
| 3  | To design fuzz   | zy inference system.  |   |
| 4  | To apply fuzzy   | techniques in power electronics and drives applications.  |   |
| Course C   | Dutcomes:<br>mpletion of the   | e course, students shall have ability to  |   |
| C513.1   | Collect the fuz  | zv and classical sets and incorporate in suitable methodology   | [AP]  |
| C513.2   | Interpret the co   | oncent of fuzzy relations and its functions   | [] [] []  |
| 0010.2   | Interpret the fuzzif   | ication and defuzzification techniques employed in real time  | [0]   |
| C513.3   | apllications   | ication and deruzzincation techniques employed in real time   | [AP]  |
| C513.4   | Design and an  | alyse the fuzzy inference system and rules creation.  | [A]   |
| C513.5   | Simulate fuzzy   | Iogic systems for various applications.   | [A]   |
| Course 0   | Contents:  |   |   |
| Module 1   | : Introduction   | to Fuzzy  | 15 Hrs  |
| sets and<br>sets- Ope<br>Relations-<br>relations-<br><b>Module 2</b><br>Features<br>Members<br>Conversion<br>Graphica<br>Weighted<br>largest a | membership, (<br>erations, Proper<br>: Cartesian pr<br>crisp equivalen<br><b>2: Fuzzification</b><br>of the Memb<br>hip Value As<br>ons: Lambda- (<br>I Techniques of<br>Average, Centi-<br>rea. | Chance versus ambiguity, Classical sets-operations, properti-<br>ties. Introduction to crisp sets and fuzzy sets- Crisp Relations and<br>roduct, Cardinality, operation, properties-Tolerance and equ-<br>ice relation, crisp tolerance relation, Fuzzy tolerance, Max-min M<br><b>and Defuzzification</b><br>Dership Function, Standard Forms and Boundaries, Fuzzi<br>signments-Intuition, Inference, Rank Ordering, Fuzzy- To<br>Cuts for Fuzzy Sets and Fuzzy Relations, Logic and Fuzzy set<br>of Inference Defuzzification Methods: Max-membership- Ce<br>re of Gravity, Centre of sums, Mean max membership, Centre of | es-Fuzzy<br>nd Fuzzy<br>uivalence<br>Aethod.<br><b>15 Hrs</b><br>fication,<br>- Crisp<br>systems,<br>entroid ,<br>f |
| Module 3<br>Fuzzy inf<br>logic cont<br>Maximum<br>MATLAB<br>Logic Co<br>Logic Co<br>Logic Con  | 3: Fuzzy Inference<br>erence systems<br>roller using Mat<br>Power Point<br>simulation - Fu<br>ntrolled SPWM<br>ntrol of Switched   | nce Systems and Applications in Ped<br>S- Mamdani and Takagi-Sugeno fuzzy models- Implementation<br>tlab fuzzy-logic toolbox, PID vs FLC Controller Fuzzy logic contr<br>Tracking (MPPT)- Recent trends in fuzzy control of electrica<br>uzzy logic speed control of three phase induction motor drive<br>Converter for Wind Energy Conversion System. Case Studie<br>d Reluctance Motor, Modelling and Fuzzy Control of DC Drive.<br>Total Hor   | 15 Hrs<br>of fuzzy<br>ol for the<br>al drives.<br>e- Fuzzy<br>s: Fuzzy<br>urs 45                                    |
| 1  | Timothy J. Ros   | ss, "Fuzzy Logic with Engineering Applications". Wiley India. 201   | 10.   |
| -  | Driankov D., F   | Hellendoorn H., Reinfrank M. "An Introduction to Fuzzy Control".  | Narosa  |
| 2  | Publications, 2  | 2014.   |   |

**Fuzzy Systems** 

systems", CRC Press, 2008.

G. Chen and T. Pham, "Introduction to fuzzy sets, fuzzy logic & Fuzzy control

Klir, George J. and Bo Yuan, "Fuzzy sets and Fuzzy Logic: Theory and

3/0/0/3

2

22PE513

| 3       | Marcian Cirstea, Andrei Dinu, Malcolm Mc Cormick, Jeen Ghee Khor, "Neural and |
|---------|---|
|         | Fuzzy Logic Control of Drives and Power Systems", Newnes Publications, 2008.  |
| Web Ref | erences:  |
| 1       | https://nptel.ac.in/courses/106105173/2                                       |
| 2       | https://onlinecourses.nptel.ac.in/noc19_ge07/preview                          |
| 3       | https://swayam.gov.in/courses/5677-jan-2019-fuzzy-logic-and-neural-networks   |

| Formative<br>Assessment | Formative Summative<br>Assessment Assessment |     |    | End Semester<br>Examination | Total |
|-------------------------|--|-----|----|-----------------------------|-------|
| 80                      | 120  | 200 | 40 | 60                          | 100   |

| Assessme  | Assessment Methods & Levels (based on Blooms' Taxonomy) |                       |    |  |  |  |  |  |
|---|---|-----------------------|----|--|--|--|--|--|
| Formative   | Assessment ba   | sed on Capstone Model |    |  |  |  |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%)<br>[80 Marks] |   |                       |    |  |  |  |  |  |
| C513.1  | Apply   | Quiz                  | 20 |  |  |  |  |  |
| C513.2  | Understand  | Presentation          | 20 |  |  |  |  |  |
| C513.3  | Analyze   | Assignment            | 20 |  |  |  |  |  |
| C513.4  | C513.4 Analyze Assignment 20                            |                       |    |  |  |  |  |  |
| C513.5  | Analyze   | Case Study            | 20 |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | - [100 Marks]                     |  |  |  |  |  |
| Remember   | 10                      | 10                      | 10                                |  |  |  |  |  |
| Understand   | 30                      | 30                      | 30                                |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                 |  |         |          |       |  |  |  |
|---------------|---|-----------------|--|---------|----------|-------|--|--|--|
|               | End   |                 |  |         |          |       |  |  |  |
|               | Semester<br>Examination                                     |                 |  |         |          |       |  |  |  |
| SA 1          | FA 1 (4   | FA 1 (40 Marks) |  | FA 2 (4 | 0 Marks) | (60%) |  |  |  |
| (60<br>Marks) | [100 Marks]   |                 |  |         |          |       |  |  |  |

| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | PO<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C513.1           | 3       | 1       | 1       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C513.2           | 3       | 2       | 2       | 1       |         |                   |         |         |         |          |          |          |          | 2        |          |
| C513.3           | 3       | 2       | 1       |         |         |                   |         |         |         |          |          | 3        |          | 2        |          |
| C513.4           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| C513.5           | 3       | 3       | 3       | 2       |         | 1                 | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | 3       | 9        | Strongl  | y Agree  | ed       |          |          |

| 22PE514   | Ма   | chine Learning Applications in Power System   | 3/0/0/3  |  |  |  |  |  |
|---|--|---|--|--|--|--|--|--|
| Nature of   | Course   | D (Theory Application)  |  |  |  |  |  |  |
| Course P  | re-requisites  | Power System Analysis   |  |  |  |  |  |  |
| Course O  | bjectives:   |   |  |  |  |  |  |  |
| 1   | Understand the   | e concept of Machine Learning (ML).   |  |  |  |  |  |  |
| 2   | Recognize the applications in Renewable energy sources.                                      |   |  |  |  |  |  |  |
| 3   | To investigate   | the effectiveness of ML in power systems.   |  |  |  |  |  |  |
| 4   | To Study abou  | It load forecasting and fault detection in power system using N   | 1L topics.   |  |  |  |  |  |
| 5   | To accomplish<br>(ANN) and Ge  | h the approach of machine learning based Artificial Neural<br>metic Algorithm (GA) in power system.   | Network  |  |  |  |  |  |
| Course Ou   | tcomes:  |   |  |  |  |  |  |  |
| Upon com  | pletion of the o   | course, students shall have ability to  |  |  |  |  |  |  |
| C514.1  | Perceive kn<br>classifications   | owledge about Machine learning concepts and its   | [U]  |  |  |  |  |  |
| C514.2  | Analyze load<br>Machine Lear   | forecasting and fault detection in power system using ning concepts.  | [A]  |  |  |  |  |  |
| C514.3  | Analyze the generation an  | concepts of machine learning in Renewable energy d monitoring.  | [A]  |  |  |  |  |  |
| C514.4  | Understand th  | ne concept of GA and ANN in power system.   | [U]  |  |  |  |  |  |
| C514.5  | Demonstrate  | Machine learning applications in smart grid.  | [AP]   |  |  |  |  |  |
| Course Co   | ontents:   |   |  |  |  |  |  |  |
| Module 1:<br>Introductic<br>types of N<br>Neighbour                   | Introduction<br>on to Machine le<br>Machine Learni<br>Artificial Neura                       | earning - History and early works - Theoretical aspects of ML -<br>ing algorithms - Linear regression, Logistic regression, K -<br>al Networks, Random Forest, and Support Vector.  | 12 Hrs<br>Different<br>Nearest                       |  |  |  |  |  |
|   |  | ning in Power Systems   |  |  |  |  |  |  |
| studies - E<br>and securi<br>and NN in                                | Economic load<br>ty assessment<br>power system   | dispatch, Unit commitment, power plant monitoring, fault ide<br>- Unconstrained and constrained optimization using Genetic<br>- Machine learning applications in smart grid.  | ntification<br>Algorithm                             |  |  |  |  |  |
| Module 3:   | Machine learn  | ning in Renewable Energy Systems  | 16 Hrs   |  |  |  |  |  |
| Machine le<br>Forecastin<br>location, s<br>accuracy of<br>forecasting | earning techniq<br>g renewable e<br>ize and configu<br>of algorithms - E<br>g based on daily | ues for renewable energy generation - Machine learning applenergy sources (Wind, Solar and Hydro power) - Determineration, Managing renewable energy integrated smart grid - For Battery Management Using Machine Learning. Case Study: Way mean wind speed and standard deviation. | ications in<br>hing plant<br>precasting<br>ind power |  |  |  |  |  |
| Text Book   | (S:  |   |  |  |  |  |  |  |
| 1   | Andrew Keller<br>Optimizing D<br>publishers, 20  | ner, Adam Kelleher, 'Machine Learning in Production- Deve<br>lata Science Workflows and Applications, 1 <sup>st</sup> Edition,<br>20.   | loping &<br>Pearson                                  |  |  |  |  |  |
| 2   | Saifullah Khal<br>Edition, GI Glo  | id, 'Applications of Artificial Intelligence in Electrical Engine bal Knowledge publisher, 2020.  | əring', 1 <sup>st</sup>                              |  |  |  |  |  |
| 3   | Rakesh Sehga<br>Kumaran, 'Sn<br>Intelligence an  | al, Neeraj Gupta, Anuradha Tomar, Mukund Dutt Sharma a<br>nart Electrical and Mechanical Systems: An Application of<br>nd Machine Learning' Elsevier Science, 2022.   | nd Vigna<br>Artificial                               |  |  |  |  |  |
| Reference   | Books:   |   | <u></u>  |  |  |  |  |  |
| 1   | Mohssen Mo<br>Bashier ,"Mac<br><u>Francis g</u> roup   | hammed, Muhammad Badruddin Khan, Eihab Bashier Mo<br>chine Learning: Algorithms and Applications", CRC Press Ta<br>, 1 <sup>st</sup> edition, 2020  | hammed<br>aylor and                                  |  |  |  |  |  |
| 2   | Morteza N<br>Abdar, Somay  | Nazari-Heris, Milad Sadat-Mohammadi, Houtan Jebell<br>veh Asadi, Behnam Mohammadi-Ivatloo, 'Application of  | i, Moloud<br>Machine                                 |  |  |  |  |  |

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|          | Learning and Deep Learning Methods to Power System Problems' Springer            |
|----------|--|
|          | International Publishing, 1 <sup>st</sup> edition, 2021.                         |
| Web Refe | erences:   |
| 1        | https://nptel.ac.in/courses/106105152  |
| 2        | https://www.datarevenue.com/en-blog/machine-learning-for-energy-distribution     |
| 2        | https://www.mdpi.com/journal/energies/special_issues/Machine_Learning_Optimizati |
| 3        | on_Power_System  |

| Formative<br>Assessment | Formative Summative<br>Assessment Assessment |     |    | End Semester<br>Examination | Total |
|-------------------------|--|-----|----|-----------------------------|-------|
| 80                      | 120  | 200 | 40 | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy)   |                    |    |  |  |  |  |  |
|-------------------|---|--------------------|----|--|--|--|--|--|
| Formative         | Formative Assessment based on Capstone Model  |                    |    |  |  |  |  |  |
| Course<br>Outcome | Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br> |                    |    |  |  |  |  |  |
| C514.1            | Understand  | Online Quiz        | 20 |  |  |  |  |  |
| C514.2            | Analyze   | Class Presentation | 20 |  |  |  |  |  |
| C514.3            | 4.3 Analyze Crown Appirgment  |                    |    |  |  |  |  |  |
| C514.4            | C514.4 Apply Group Assignment 20  |                    |    |  |  |  |  |  |
| C514.5            | Understand  | Case Study         | 20 |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                         |      |         |          |       |  |  |  |
|---------------|---|-------------------------|------|---------|----------|-------|--|--|--|
|               | End   |                         |      |         |          |       |  |  |  |
|               | arks  | Semester<br>Examination |      |         |          |       |  |  |  |
| SA 1          | FA 1 (4   | 0 Marks)                | SA 2 | FA 2 (4 | 0 Marks) | (60%) |  |  |  |
| (60<br>Marks) | [100 Marks]   |                         |      |         |          |       |  |  |  |

| No. of<br>the CO | РО<br>1             | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5           | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------------------|---------|---------|---------|-------------------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C514.1           | 3                   | 3       | 2       | 2       |                   |         |         |         |         |          |          |          | 3        | 2        |          |
| C514.2           | 3                   | 3       | 2       | 2       |                   |         |         |         |         |          |          |          | 3        | 2        |          |
| C514.3           | 3                   | 3       | 3       | 3       |                   |         |         |         |         | 2        |          |          | 3        | 2        |          |
| C514.4           | 3                   | 3       | 3       | 3       |                   |         |         |         |         |          |          |          | 3        | 2        |          |
| C514.5           | 3                   | 3       | 2       | 2       |                   |         |         |         |         | 2        |          |          | 3        | 2        |          |
| 1                | Reasonably Agreed 2 |         |         | 2       | Moderately Agreed |         |         | 3       | 9       | Strong   | y Agree  | ed       |          |          |          |

| Course (  | Dhiectives:  |   |
|---|--|---|
| 1   | To study the concept of state models, controllability and observability  |   |
| 2   | To acquire the knowledge on non-linear systems and describing function metho   | ds.   |
| 3   | To understand and analyse the liapunov stability method  |   |
| U   | To understand the optimal control and adaptive control concepts and analyse the  | ne  |
| 4   | problems   |   |
| Course (  | Dutcomes:  |   |
| Upon co   | mpletion of the course, students shall have ability to   | 1   |
| C515.1  | Infer the fundamental concepts of linear systems.  | [U]   |
| C515.2  | Interpret the application of non-linear system concepts and describing function method.  | [AP]  |
| C515.3  | Analyse the stability of non-linear system using Liapunov method.  | [A]   |
| C515.4  | Solve the regulator and tracking problems.   | [AP]  |
| C515.5  | Analyse the optimal control and adaptive control problems.   | [A]   |
| Course (  | Contents:  |   |
| Module 1  | I. Linear and Non-Linear Systems   | 15 Hrs  |
| continuou<br>Observat<br>Typical e<br>trajectorie                                     | Is systems. Diagonalization-Solution of state equations - Concepts of Controllability - Pole placement by state feedback Observer systems - Types of non-linexamples - Phase plane analysis-Singular points-Limit cycles-Construction of es - Describing function method-Derivation of describing functions.   | ility and<br>hearity -<br>f phase                             |
| Module 2<br>Stability<br>method c<br>systems.   | 2: Liapunov stability analysis<br>in the sense of Liapunov-Definiteness of scalar Functions-Quadratic forms -<br>of Liapunov-Liapunov stability analysis of linear time invariant systems and non  | <b>15 Hrs</b><br>Second<br>- linear                           |
| Module 3<br>Servome<br>approach<br>the track<br>Control: I<br>Control: I<br>Control-N | 3: Optimal and Advanced Control Systems Parameter Optimization 1<br>chanisms-Optimal Control Problems: Transfer function Approach-State v<br>-the state regulator problem-The Infinite-time regulator problem-Output regula<br>ing Problems-Parameter Optimization: Regulators (Continuous system only)-A<br>Model-Reference Adaptive Control fundamental concepts-Self tuning control -<br>Parameter perturbations - Design of robust control system-PID controllers-Fuzz<br>leural Network Controller. | 5 Hrs<br>variable<br>tor and<br>daptive<br>Robust<br>cy Logic |
| Toxt Boo  | Total Hour   | rs 45   |
| 1   | Benjamin C.Kuo. "Automatic Control Systems", Prentice Hall of India Private Ltd<br>New Delhi, 10th Edition, 2017.  | l.,   |
| 2   | Nagrath.I.J. and Gopal. M. "Control Systems Engineering", New Age Internation Pvt Limited, New Delhi, Fourth Edition, 2015.  | al  |
| 3   | Katsuhiko Ogata, "Modern Control Engineering", Pearson Education, New Delhi Fifth Edition, 2010.   | ,   |
| Reference   | e Books:   |   |
| 1<br>2  | VVIIIam L Brogan, "Modern Control Theory", Dorling Kindersley (India) Pvt. Ltd.,<br>Aggarwal K.K. "Control System Analysis and Design", Khanna Publishers, New   | 2011.   |
| 3   | Deini, First edition, 2004.<br>Horacio J Marquez, "Nonlinear Control Systems: Analysis and Design" John Wi   | ilev &  |
|   |  |   |
| R2022   | M.E Power Electronics and Drives   | Page 79   |
|   |  |   |

| ipon co | mpletion of the course, students shall have ability to                                  |      |
|---------|---|------|
| C515.1  | Infer the fundamental concepts of linear systems.                                       | [U]  |
| C515.2  | Interpret the application of non-linear system concepts and describing function method. | [AP] |
| C515.3  | Analyse the stability of non-linear system using Liapunov method.                       | [A]  |
| C515.4  | Solve the regulator and tracking problems.  | [AP] |
| C515.5  | Analyse the optimal control and adaptive control problems.                              | [A]  |
|         | Pontonto:   |      |

System Theory

G (Theory Analytical) Course Pre-requisites Linear Algebra, Transforms and Numerical Methods

22PE515

Nature of Course

3/0/0/3

|         | Sons Inc, 2008.  |
|---------|--|
| Web Ref | erences:   |
| 1       | https://nptel.ac.in/courses/108106024/   |
| 2       | https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-243j |
|         | dynamics-of-nonlinear-systems-fall-2003/lecture-notes/                         |
| 3       | https://magnus.ece.gatech.edu/ece6552.html                                     |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy) |  |                        |  |  |  |  |  |  |  |
|-------------------|---|--|------------------------|--|--|--|--|--|--|--|
| Formative         | Assessment ba   | sed on Capstone Model  |                        |  |  |  |  |  |  |  |
| Course<br>Outcome | Bloom's<br>Level  | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |  |  |  |  |
| C515.1            | Understand  | Quiz   | 20                     |  |  |  |  |  |  |  |
| C515.2            | Apply   | Presentation   | 20                     |  |  |  |  |  |  |  |
| C515.3            | Analyze   | Assignment   | 20                     |  |  |  |  |  |  |  |
| C515.4            | C515.4 Apply Assignment 20                              |  |                        |  |  |  |  |  |  |  |
| C515.5            | Analyze   | Case Study   | 20                     |  |  |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                          |  |  |  |  |  |  |
|--|-------------------------|-------------------------|--------------------------|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>[arks] | End Semester Examination |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]              |  |  |  |  |  |  |
| Remember   | 10                      | 10                      | 10                       |  |  |  |  |  |  |
| Understand   | 10                      | 10                      | 10                       |  |  |  |  |  |  |
| Apply  | 40                      | 40                      | 40                       |  |  |  |  |  |  |
| Analyse  | 40                      | 40                      | 40                       |  |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                        |  |  |  |  |  |  |
| Create   | -                       | -                       | -                        |  |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |                      |               |       |                         |  |  |  |
|---------------|---|---------------------------------|----------------------|---------------|-------|-------------------------|--|--|--|
|               |   | Continuous As<br>[200           | sessment (<br>Marks] | (40%)         |       | End                     |  |  |  |
|               | CA 1 : 100 Ma   | arks                            |                      | CA 2 : 100 Ma | arks  | Semester<br>Examination |  |  |  |
| SA 1          | FA 1 (40  | 0 Marks)                        | SA 2                 | FA 2 (4       | (60%) |                         |  |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component -<br>II<br>(20 Marks) | [100 Marks]          |               |       |                         |  |  |  |

| No. of<br>the CO | РО<br>1           | PO<br>2 | РО<br>3 | PO<br>4 | РО<br>5           | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|-------------------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C515.1           | 3                 | 1       | 1       | 1       |                   |         |         |         |         |          |          |          |          | 2        |          |
| C515.2           | 3                 | 2       | 2       | 1       |                   |         |         |         |         |          |          |          |          | 2        |          |
| C515.3           | 3                 | 2       | 1       |         |                   |         |         |         |         |          |          | 3        |          | 2        |          |
| C515.4           | 3                 | 3       | 3       | 2       |                   | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| C515.5           | 3                 | 3       | 3       | 2       |                   | 1       | 1       |         |         |          |          | 2        |          | 3        |          |
| 1                | Reasonably Agreed |         | greed   | 2       | Moderately Agreed |         |         | 3       | 5       | Strong   | y Agree  | ed       |          |          |          |

| 22PE516   |                  | DSP Based System Design 3                                    |          |  |  |  |  |  |  |
|-----------|------------------|--|----------|--|--|--|--|--|--|
| Nature of | Course           | D (Theory Application)                                       |          |  |  |  |  |  |  |
| Course P  | re-requisites    |  |          |  |  |  |  |  |  |
| Course O  | bjectives:       |  |          |  |  |  |  |  |  |
| 1         | To understand    | d various representation methods of DSP system               |          |  |  |  |  |  |  |
| 2         | To provide ins   | ight about different DSP algorithms                          |          |  |  |  |  |  |  |
| 3         | To familiarize   | the various architectures of DSP system                      |          |  |  |  |  |  |  |
| 4         | To perform a     | nalysis of DSP architectures and to learn the implementation | n of DSP |  |  |  |  |  |  |
| •         | system in pro    | ogrammable hardware  |          |  |  |  |  |  |  |
| 5         | To learn the d   | etails of DSP system interfacing with other peripherls       |          |  |  |  |  |  |  |
| Course Ou | tcomes:          |  |          |  |  |  |  |  |  |
| Upon com  | pletion of the o | course, students shall have ability to                       |          |  |  |  |  |  |  |
| C516.1    | Evaluate the D   | DSP system using various methods                             | [A]      |  |  |  |  |  |  |
| C516.2    | Design algorit   | hm suitable for different DSP applications                   | [A]      |  |  |  |  |  |  |
| C516.3    | Explain variou   | s architectures of DSP system                                | [U]      |  |  |  |  |  |  |
| C516.4    | Implement DS     | P system in programmable hardware.                           | [AP]     |  |  |  |  |  |  |
| C516.5    | Build interfacir | ng of DSP system with various peripherals.                   | [AP]     |  |  |  |  |  |  |
| 0         | 4 4 .            |  |          |  |  |  |  |  |  |

#### Course Contents:

#### Module 1: Representation of DSP System

Single Core and Multicore, Architectural requirement of DSPs - high throughput, low cost, low power, small code size, embedded applications. Representation of digital signal processing systems - block diagrams, signal flow graphs, data-flow graphs, dependence graphs. Techniques for enhancing computational throughput - parallelism and pipelining.

#### Module 2: DSP algorithms and System Architecture

DSP algorithms - Convolution, Correlation, FIR/IIR filters, FFT, adaptive filters, sampling rate converters, DCT, Decimator, Expander and Filter Banks. DSP applications. Computational characteristics of DSP algorithms and applications, Numerical representation of signals-word length effect and its impact, Carry free adders, Multiplier- Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Features for External Interfacing. VLIW architecture. Basic performance issue in pipelining, Simple implementation of MIPS, Instruction Level Parallelism, Dynamic Scheduling,Dynamic Hardware Prediction, Memory hierarchy.Study of FIxed point and floating point DSP architectures.

### Module 3: Architecture Analysis On Programmable Hardware And System Interfacing

15 Hrs

Analysis of basic DSP Architectures on programmable hardwares. Algorithms for FIR , IIR, Lattice filter structures, architectures for real and complex fast Fourier transforms, 1D/2D Convolutions, Winograd minimal filtering algorithm. FPGA: Architecture, different sub-systems, design flow for DSP system design, mapping of DSP algorithms onto FPGA.- Examples of digital signal processing algorithms suitable for parallel architectures such as GPUs and multiGPUs. Interfacing: Introduction, Synchronous Serial Interface CODE, A CODEC Interface Circuit, ADC interface.

| S:   |
|--|
| Architectures for Digital Signal Processing, Peter Pirsch John Weily, 2007   |
| Digital Signal Processing and Application with C6713 and C6416 DSK, Rulph    |
| Chassaing, Worcester Polytechnic Institute, A Wiley Interscience Publication |
| Books:   |
| Digital Signal Processing and Application with C6713 and C6416 DSK, Rulph    |
| Chassaing, Worcester Polytechnic Institute, A Wiley Interscience Publication |
|  |

#### R2022

#### 15 Hrs

15 Hrs

| 2               | K. K. Parhi - VLSI Digital Signal Processing Systems - Wiley-1999.          |  |  |  |
|-----------------|---|--|--|--|
| Web References: |   |  |  |  |
| 1.              | https://www.tutorialspoint.com/digital_signal_processing/                   |  |  |  |
| 2.              | https://www.allaboutcircuits.com/projects/category/embedded/digital-signal- |  |  |  |
|                 | processing/   |  |  |  |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy)   |               |                       |    |  |  |
|---|---------------|-----------------------|----|--|--|
| Formative   | Assessment ba | sed on Capstone Model |    |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%)[80 Marks] |               |                       |    |  |  |
| C516.1  | Analyze       | Quiz                  | 20 |  |  |
| C516.2  | Analyze       | Presentation          | 20 |  |  |
| C516.3  | Understand    | Assignment 20         |    |  |  |
| C516.4  | Apply         |                       | 20 |  |  |
| C516.5  | Apply         | Case Study            | 20 |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |                                   |  |  |  |  |
|--|-------------------------|------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      | [100 Marks]                       |  |  |  |  |
| Remember   | 10                      | 10                     | 10                                |  |  |  |  |
| Understand   | 30                      | 30                     | 30                                |  |  |  |  |
| Apply  | 30                      | 30                     | 30                                |  |  |  |  |
| Analyse  | 30                      | 30                     | 30                                |  |  |  |  |
| Evaluate   | -                       | -                      | -                                 |  |  |  |  |
| Create   | -                       | -                      | -                                 |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |               |                                |                                 |             |  |
|---|--------------------------------|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|
|   | End                            |                                 |               |                                |                                 |             |  |
|   | arks                           | Semester<br>Examination         |               |                                |                                 |             |  |
| SA 1  | FA 1 (40                       | FA 1 (40 Marks)                 |               |                                | 0 Marks)                        | (60%)       |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |

| No. of<br>the CO | РО<br>1 | PO<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | РО<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C516.1           | 3       | 2       | 2       |         |         |                   |         |         |         |          |          | 1        | 3        |          |          |
| C516.2           | 3       | 2       | 2       |         |         |                   |         |         | 2       |          |          | 1        | 2        |          | 2        |
| C516.3           | 3       | 2       |         |         |         |                   |         |         |         | 1        |          | 1        |          |          |          |
| C516.4           | 3       | 2       | 1       | 1       |         |                   |         |         |         | 1        |          | 1        |          |          |          |
| C516.5           | 3       | 2       | 1       | 1       |         |                   |         |         |         | 1        |          | 1        |          |          |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed |         |         | 3       |          | Strong   | y Agree  | ed       |          |          |

| 22PE517   |                                 | HVDC and FACTS  | 3/0/0/3   |  |  |  |
|---|---------------------------------|---|-----------|--|--|--|
| Nature of Course         D (Theory Application) |                                 |   |           |  |  |  |
| Course P  | re-requisites                   |   |           |  |  |  |
| Course O  | bjectives:                      |   |           |  |  |  |
| 1   | To emphasis t                   | he need for FACTS controllers.                                |           |  |  |  |
| 2   | To learn the c controllers.     | characteristics, applications and modeling of series and shun | t FACTS   |  |  |  |
| 3   | To analyze t<br>coordination    | he interaction of different FACTS controller and perform      | o control |  |  |  |
| 4   | To impart know                  | wledge on operation, modelling and control of HVDC link       |           |  |  |  |
| 5   | To perform ste                  | eady state analysis of AC/DC system.                          |           |  |  |  |
| Course Ou<br>Upon com                           | itcomes:<br>pletion of the c    | course, students shall have ability to                        |           |  |  |  |
| C517.1  | Refresh on ba<br>controllers    | sics of power transmission networks and need for FACTS        | [A]       |  |  |  |
| C517.2  | Design series<br>enhancement    | and shunt compensating devices for power transfer             | [A]       |  |  |  |
| C517.3  | Infer the signif<br>controllers | ficance about different voltage source converter based FACTS  | [U]       |  |  |  |
| C517.4  | Attain knowled<br>HVDC link     | dge on AC/DC system coordinated control with FACTS and        | [AP]      |  |  |  |
| C517.5  | Capable to ex<br>MTDC system    | plore the MMC converter applications FACTS and                | [AP]      |  |  |  |

#### Course Contents:

#### Module 1: Introduction

15 Hrs

Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers - Need for HVDC system-MTDC system -Review of basics of LCC and VSC HVDC system. Configurations - Monopolar Asymmetric and Symmetric MMC-HVDC Scheme- Bipolar and Homopolar HVDC Scheme- Multi-Terminal HVDC Configuration- Layout of HVDC system (LCC, VSC)

## Module 2: Thyristor Based Facts Controllers and Analysis OF LCC HVDC Converters And HVDC System Control 15 Hrs

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for power flow analysis-Stability studies- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line-Concepts of Controlled Series Compensation-Operation of TCSC- Analysis of TCSC-Modelling of TCSC for power flow and stability studies. Choice of converter configuration-Simplified analysis of Graetz circuit Converter bridge characteristics-characteristics of a twelve pulse converter- detailed analysis of converters. General principles of DC link control-Converter control characteristics-System control hierarchy -Firing angle control-Current and extinction angle control-Generation of harmonics and filtering power control-Higher level controllers. Modelling of LCC HVDC system and controllers, transformer derating and core saturation instability, Concepts of Power Oscillation Damping Controller, Frequency Controller and Sub synchronous Damping controller in LCC HVDC.

#### Module 3: Voltage Source Converter Based HVDC, FACTS and system control 15 Hrs

Static synchronous compensator (STATCOM) - Static synchronous series compensator (SSSC) Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC-Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers (UPFC) - Modelling of UPFC and IPFC for power flow and transient stability studies-Concepts of Power Oscillation Damping using FACTS controllers-Applications VSC based HVDC: Operation, Modelling for steady state and dynamic studies. Introduction to Modular Multilevel converters- Main circuit design-Converter Operating principle and Averaged Dynamic Model- Per-Phase Output-Current Control - Arm-Balancing (Internal) Control- Vector Output-Current Control-Higher-Level Control-Modulation and Sub module Energy Balancing- Offshore HVDC integration System Studies -Control and Protection of MMC-HVDC under AC and DC Network Fault Contingencies- Modeling and Simulation of MMC based MTDC Simulation exercises, Steady state, Fault recovery characteristics - Solution of DC load flow-Solution of AC-DC power flow: Sequential and Simultaneous methods

Total Hours 45

| Text Bool | (S:  |
|-----------|--|
| 1         | Mohan Mathur, R., Rajiv. K. Varma, "Thyristor-Based Facts Controllers        |
| 1         | forElectrical Transmission Systems", IEEE press and John Wiley & Sons, Inc   |
| 2         | K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution", New |
| 2         | AgeInternational(P) Ltd., Publishers, New Delhi, Reprint 2008.               |
| Reference | e Books:   |
| 1         | J.Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus,    |
|           | London,1983  |
| 2         | V.K.Sood, "HVDC and FACTS controllers- Applications of Static Converters in  |
|           | Power System", Kluwer Academic Publishers 2004                               |
| Web Refe  | rences:  |
| 1.        | http://whatis.techtarget.com/reference/Smart-Grid-Technology-Overview        |
| 2.        | https://nptel.ac.in/courses/108107113/                                       |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy)   |  |              |    |  |  |  |
|---|--|--------------|----|--|--|--|
| Formative   | Formative Assessment based on Capstone Model |              |    |  |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%)<br>[80 Marks] |  |              |    |  |  |  |
| C517.1  | Analyze                                      | Quiz         | 20 |  |  |  |
| C517.2  | Analyze                                      | Presentation | 20 |  |  |  |
| C517.3  | Understand                                   | Assignment   | 20 |  |  |  |
| C517.4  | Apply  |              |    |  |  |  |
| C517.5  | Apply  | Case Study   | 20 |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>Iarks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |
| Remember   | 10                      | 10                      | 10                                |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |
| Apply  | 40                      | 40                      | 40                                |  |  |  |  |
| Analyse  | 20                      | 20                      | 20                                |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |             |  |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|--|
|               | End   |                                 |               |                                |                                 |             |  |  |
|               | Semester<br>Examination                                     |                                 |               |                                |                                 |             |  |  |
| SA 1          | FA 1 (4   | FA 1 (40 Marks)                 |               | FA 2 (40 Marks)                |                                 | (60%)       |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C517.1           | 3       | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C517.2           | 3       | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C517.3           | 2       | 1       |         |         |         |         |         |         | 2       |          |          | 1        | 3        |          | 2        |
| C517.4           | 3       | 2       | 1       | 1       |         |         |         |         |         | 1        |          | 1        |          |          |          |
| C517.5           | 3       | 2       | 1       | 1       |         |         |         |         |         | 1        |          | 1        |          |          |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Ν       | loder   | ately   | Agre    | ed       | 3        | ę        | Strong   | y Agree  | ed       |

| 22PE518                |   | Machine Learning and Deep Learning   | 3/0/0/3     |  |  |  |  |  |  |
|------------------------|---|--|-------------|--|--|--|--|--|--|
| Nature of              | Course  | D (Theory Application)   |             |  |  |  |  |  |  |
| Course P               | re-requisites   |  |             |  |  |  |  |  |  |
| Course O               | Course Objectives:  |  |             |  |  |  |  |  |  |
| 1                      | 1 Understanding about the learning problem and algorithms   |  |             |  |  |  |  |  |  |
| 2                      | 2 Providing insight about neural networks   |  |             |  |  |  |  |  |  |
| 3                      | Introducing the   | e machine learning fundamentals and significance   |             |  |  |  |  |  |  |
| 4                      | Enabling the s  | tudents to acquire knowledge about pattern recognition.  |             |  |  |  |  |  |  |
| 5                      | Motivating the<br>problems  | e students to apply deep learning algorithms for solving   | real life   |  |  |  |  |  |  |
| Course Ou<br>Upon com  | itcomes:<br>pletion of the c  | course, students shall have ability to   |             |  |  |  |  |  |  |
| C518.1                 | Illustrate the c  | ategorization of machine learning algorithms   | [A]         |  |  |  |  |  |  |
| C518.2                 | Compare and functions   | contrast the types of neural network architectures, activation   | [A]         |  |  |  |  |  |  |
| C518.3                 | Acquaint with   | the pattern association using neural networks  | [U]         |  |  |  |  |  |  |
| C518.4                 | Elaborate vari<br>architectures of  | ous terminologies related with pattern recognition and<br>of convolutional neural networks                     | [AP]        |  |  |  |  |  |  |
| C518.5                 | Construct diffe<br>advanced neu<br>and GANs.  | erent feature selection and classification techniques and ral network architectures such as RNN, Autoencoders, | [AP]        |  |  |  |  |  |  |
| Course C               | ontents:  |  |             |  |  |  |  |  |  |
| Module 1               | : Learning Prol   | blems And Algorithms Neural Networks   | 15 Hrs      |  |  |  |  |  |  |
| Various pa             | aradigms of lea   | rning problems, Supervised, Semi-supervised and Unsupervis   | ed          |  |  |  |  |  |  |
| Algorithm              | s-Differences be  | etween Biological and Artificial Neural Networks - Typical Arc   | chitecture, |  |  |  |  |  |  |
| Common                 | Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net,   |  |             |  |  |  |  |  |  |
| Perceptro<br>Hebb rule | Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association -<br>Hebb rule and Delta rule. Hetero associative. Auto associative. Kohonen Self Organising Maps. |  |             |  |  |  |  |  |  |

Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

**Module 2: Machine learning-fundamentals & feature selections & Classifications 15 Hrs** Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

#### Module 3: DEEP LEARNING

#### 15 Hrs

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.- State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders,GANs: The discriminator, generator, DCGANs

 Text Books:
 J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A
 45

 1
 J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A
 1

 2
 Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN:9780262035613, 2016.
 1

 Reference Books:
 1
 The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman.Second Edition. 2009.
 2

 2
 Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.

#### Web References:

- 1. http://user.engineering.uiowa.edu/~ie238/Lecture/Soft\_computing
- 2. http://www.cse.iitm.ac.in/~vplab/courses/soft\_computing.html

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessme  | Assessment Methods & Levels (based on Blooms' Taxonomy) |              |    |  |  |  |  |  |
|---|---|--------------|----|--|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model            |              |    |  |  |  |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%)<br>[80 Marks] |   |              |    |  |  |  |  |  |
| C518.1  | Analyze   | Quiz         | 20 |  |  |  |  |  |
| C518.2  | Analyze   | Presentation | 20 |  |  |  |  |  |
| C518.3  | Understand  | Assignment   | 20 |  |  |  |  |  |
| C518.4  | C518.4 Apply Assignment 20                              |              |    |  |  |  |  |  |
| C518.5  | Apply   | Case Study   | 20 |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                        |  |  |  |  |  |
|--|-------------------------|------------------------|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>arks] | End Semester Examination<br>(60%)<br>[100 Marks] |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]      |  |  |  |  |  |
| Remember   | 20                      | 20                     | 20   |  |  |  |  |
| Understand   | 20                      | 20                     | 20   |  |  |  |  |
| Apply  | 30                      | 30                     | 30   |  |  |  |  |
| Analyse  | 30                      | 30                     | 30   |  |  |  |  |
| Evaluate   | -                       | -                      | -  |  |  |  |  |
| Create   | -                       | -                      | -  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |             |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|
|               | End   |                                 |               |                                |                                 |             |  |
|               | Semester<br>Examination                                     |                                 |               |                                |                                 |             |  |
| SA 1          | FA 1 (40  | 0 Marks)                        | SA 2          | FA 2 (4                        | Marks) (60%)                    | (60%)       |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5 | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C518.1           | 3       | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C518.2           | 3       | 3       | 2       | 2       |         |         |         |         |         |          |          | 1        | 3        |          |          |
| C518.3           | 2       | 1       |         |         |         |         |         |         | 2       |          |          | 1        | 3        |          | 2        |
| C518.4           | 3       | 2       | 1       | 1       |         |         |         |         |         | 1        |          | 1        |          |          |          |
| C518.5           | 3       | 2       | 1       | 1       |         |         |         |         |         | 1        |          | 1        |          |          |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Ν       | loder   | ately   | Agre    | ed       | 3        | ç        | Strongl  | y Agree  | ed       |

| 22PB517   |  | Internet of Everything   | 3/0/0/3   |  |  |  |  |  |  |  |
|-----------|--|--|-----------|--|--|--|--|--|--|--|
| Nature o  | f Course   | G (Theory Analytical)  |           |  |  |  |  |  |  |  |
| Course I  | Pre-requisites   | NIL  |           |  |  |  |  |  |  |  |
| Course (  | Objectives:  |  |           |  |  |  |  |  |  |  |
| 1         | To Understand  | d the vision of IOT from a global context.   |           |  |  |  |  |  |  |  |
| 2         | To enable the  | students to understand the State of the Art-IOT Architecture.  |           |  |  |  |  |  |  |  |
| 3         | To help the st   | idents to understand the principles of design in prototyping and   |           |  |  |  |  |  |  |  |
| 4         | provide ability  | to change and modify it.   |           |  |  |  |  |  |  |  |
| 5         | To be able to a  | To be able to analyze the concepts of Industry 4.0   |           |  |  |  |  |  |  |  |
| 6         | To illustrate the  | e Application of Industrial IOT.   |           |  |  |  |  |  |  |  |
| Course (  | Dutcomes:  |  |           |  |  |  |  |  |  |  |
| Upon co   | mpletion of the  | e course, students shall have ability to   |           |  |  |  |  |  |  |  |
| C517.1    | Understanding  | g the concepts of IOT from a global context.   | [U]       |  |  |  |  |  |  |  |
| C517.2    | Infer the archit   | tecture of IOT and future development.   | [U]       |  |  |  |  |  |  |  |
| C517.3    | Understand th  | ne role of network layers in Data Management using IOT.  | [U]       |  |  |  |  |  |  |  |
| C517 4    | Interpret the fe   | eatures of prototyping the embedded devices for IOT  |           |  |  |  |  |  |  |  |
| 0317.4    | applications.  |  |           |  |  |  |  |  |  |  |
| C517.5    | 5 Design and develop an effective usage of IIOT deployment for different |  |           |  |  |  |  |  |  |  |
|           | sectors.   |  |           |  |  |  |  |  |  |  |
| C517.6    | Constraints  |  |           |  |  |  |  |  |  |  |
| Course (  | Constraints.   |  |           |  |  |  |  |  |  |  |
| Course    |  |  |           |  |  |  |  |  |  |  |
| Module 1  | I: Fundamenta  | Is of IOT and IOT Protocols  | 15 Hrs    |  |  |  |  |  |  |  |
| Introduct | ion-Characteris  | stics-Physical design - Sensing & actuation- Protocols-Logical   | design-   |  |  |  |  |  |  |  |
|           | V2M Euturo c   | -input and output devices for for lot -lot Levels-Domain Speci   | Intornot  |  |  |  |  |  |  |  |
|           | ication- IP add  | resses MAC addresses- TCP and LIDP ports- Application  | laver     |  |  |  |  |  |  |  |
| protocols | - IEEE 802 con   | nmittee family of protocols- physical layer-Media access control   | laver.    |  |  |  |  |  |  |  |
| Modulo    |  |  | 15 Uro    |  |  |  |  |  |  |  |
| Globaliza | ation and Emer   | aing Issues. The Fourth Revolution, I FAN Production System  | IS MAR    |  |  |  |  |  |  |  |
| and Cor   | nected Busine  | ess Perspective, Smart Factories, Cyber Physical Systems a   | and Next  |  |  |  |  |  |  |  |
| Generati  | on Sensors, Co   | Ilaborative Platform and Product Lifecycle Management, Augme   | ented     |  |  |  |  |  |  |  |
| Reality a | nd Virtual Reali   | ity, Artificial Intelligence, Big Data and Advanced Analysis, Cybe   | r         |  |  |  |  |  |  |  |
| security  | n Industry 4.0.  |  |           |  |  |  |  |  |  |  |
| Module    | 3: Industrial IO   | т  | 15 Hrs    |  |  |  |  |  |  |  |
| Industria | al Processes, I  | ndustrial Sensing & Actuation, Industrial Internet Systems, E  | Business  |  |  |  |  |  |  |  |
| Model a   | and Reference  | Architecture: IIoT-Business Models, IIoT Reference Architecture: IIoT-Business Models, IIoT Reference Architecture | hitecture |  |  |  |  |  |  |  |
| Industria | I IoT- Layers:   | IIoT Sensing, IIoT Processing, IIoT Communication IIoT Net   | working,  |  |  |  |  |  |  |  |
| Cloud C   | omputing in II   | oT- Fog Computing in IIoT, Security in IIoT - Application D  | omains:   |  |  |  |  |  |  |  |
| Factories | and Assembly   | v Line, Food Industry, Healthcare, Plant Safety and security, App  | lications |  |  |  |  |  |  |  |
| OT UAVS   | in industries.   |  |           |  |  |  |  |  |  |  |
|           | -  | Total Hou  | urs 45    |  |  |  |  |  |  |  |
| Text Boo  | oks:   | on and Haakim Caasimally," Designing the laters of of This wa  |           |  |  |  |  |  |  |  |
| 1         |  | en and mackim Cassimally, Designing the internet of Things",   |           |  |  |  |  |  |  |  |

| 2         | "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist ,Apress, |
|-----------|---|
|           | 2016.   |
| 2         | Internet of Things: Cyber manufacturing Systems"by Sabina Jeschke, Christian      |
| 3         | Brecher, Houbing Song, Danda B. Rawat ,Springer,2017.                             |
| Reference | ce Books:   |
| 1         | Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to       |
|           | Connecting Everything", 1st Edition, Apress Publications, 2013.                   |
| 2         | Manoel Carlos Ramon, "Intel® Galileo and Intel® Galileo Gen 2: API Features and   |
|           | Arduino Projects for Linux Programmers", 1st Edition, Apress, 2014.               |
| 3         | Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things -key    |
|           | applications and Protocols",1st Edition, Wiley,2012.                              |
| Web Ref   | erences:  |
| 1         | http://www.cisco.com/c/en_in/solutions/internet-of-things/resources.html          |
| 2         | https://openwsn.atlassian.net/wiki  |
| Online R  | Resources:  |
| 1         | http://iot.ieee.org/newsletter/january-2016/hypercat-resource-discovery-onthe-    |
|           | internet-of-things.html   |
| 2         | https://www.coursera.org/specializations/Internet-of-things                       |

| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy)   |  |               |    |  |  |  |  |  |
|---|--|---------------|----|--|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model |               |    |  |  |  |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)F[8] |  |               |    |  |  |  |  |  |
| C517.1  | Understand                                   | Quiz          | 20 |  |  |  |  |  |
| C517.2  | Understand                                   | Presentation  | 20 |  |  |  |  |  |
| C517.3  | Understand                                   | Assignment    | 20 |  |  |  |  |  |
| C517.4  | Apply  | Assignment    | 20 |  |  |  |  |  |
| C517.5  | Analyse                                      | Coop Study 20 |    |  |  |  |  |  |
| C517.6  | Apply  |               | 20 |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       |                                   |  |  |  |  |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |             |  |  |  |  |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|--|--|--|--|
|               | End   |                                 |               |                                |                                 |             |  |  |  |  |  |
|               | Semester<br>Examination                                     |                                 |               |                                |                                 |             |  |  |  |  |  |
| SA 1          | FA 1 (4   | 0 Marks)                        | SA 2          | FA 2 (40 Marks)                |                                 | (60%)       |  |  |  |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |  |  |  |  |

| Component - | Component -<br>II | Component -<br>I | Component -<br>II |  |
|-------------|-------------------|------------------|-------------------|--|
| (4 Marks)   | (4 Marks)         | (4 Marks)        | (4 Marks)         |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | PO<br>6           | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|-------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C517.1           | 2       | 1       |         |         |         |                   |         |         | 2       |          |          | 1        | 3        |          | 3        |
| C517.2           | 2       | 1       |         |         |         |                   |         |         | 2       |          |          | 1        | 3        |          | 3        |
| C517.3           | 2       | 1       |         |         |         |                   |         |         | 2       |          |          | 1        | 3        |          | 3        |
| C517.4           | 3       | 2       | 1       | 1       |         |                   |         |         |         | 1        |          | 2        | 3        | 3        |          |
| C517.5           | 3       | 3       | 2       | 2       |         |                   |         |         |         |          |          | 1        | 3        |          |          |
| C517.6           | 3       | 2       | 1       | 1       |         |                   |         |         |         | 1        |          | 2        | 3        | 3        |          |
| 1                | Rea     | sonab   | ly Ag   | reed    | 2       | Moderately Agreed |         |         |         |          | 3        |          | Strong   | y Agree  | d        |

| 22PB519   |                  | Research Methodology and IPR                                      | 3/0/0/3     |
|-----------|------------------|---|-------------|
| Nature of | Course           | D (Theory Application)  |             |
| Course P  | re-requisites    | Nil   |             |
| Course O  | bjectives:       |   |             |
| 1         | To impart know   | wledge of handling data for carrying out research work effective  | ely.        |
| 2         | To impart the    | ability to use optimization technique for problem solving.        |             |
| 3         | To impart deci   | ision making skills using statistical tool.                       |             |
| 4         | To impart repo   | ort writing skills.   |             |
| 5         | To impart kno    | wledge about the procedure for filing patent and protecting ir    | ntellectual |
| 5         | properties righ  | nt.   |             |
| Course Ou | itcomes:         |   |             |
| Upon com  | pletion of the o | course, students shall have ability to                            |             |
| C519.1    | Understand th    | ne fundamental search concepts and data collection methods        | ; [U]       |
|           | for conducting   | research work.  |             |
| C519.2    | Experiment th    | e test hypothesis and analyze the outcome.                        | [A]         |
| C519.3    | Report the res   | search work and write research proposals for various funding      | J [Ap]      |
|           | agencies.        |   |             |
| C519.4    | Analyze the p    | rocedure for patent rights, licensing and transfer of technology. | [A]         |
| Course C  | ontents:         |   |             |

#### **Module 1: Fundamentals and Data Collection**

Research methodology - definition, objectives, mathematical tools for analysis, Research design. Types of research, exploratory research, conclusive research, modelling research, algorithmic research, Research process- steps. Data collection methods- Primary data-observation method, personal interview, telephonic interview, mail survey, questionnaire design. **Hypotheses Testing and Analysis:** Hypotheses testing-Testing of hypotheses concerning means, concerning variance-one tailed Chi-square test. Introduction to Discriminant analysis, Factor analysis, cluster analysis, multidimensional scaling, conjoint analysis. **Optimization Tools:** Introduction about Taguchi, Artificial Neural Network, Grey Relationship Analysis, Design of Experiment, Life cycle Assessment.

#### Module 2: Report Writing and Presentation

Report writing- Types of report, guidelines to review report, report format, typing instructions, oral presentation, power point presentation, Data analysis using excel sheet, Proposal submission for funding agencies. Plagiarism, tools to avoid plagiarism, research ethics. Case study: (Use software) report format, Prepare review paper, Reference formation end note, Grammar verification. **Patent Rights:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

#### Module 3 Nature of Intellectual Property

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

|           | Total Hours   45   |
|-----------|--|
| Text Bool | KS:  |
| 1         | Ranjith Kumar, Research Methodology, SAGE publication, 2018.   |
| 2         | Robert Coe, Michael Waring, Larry V Hadges, James Aruthur, Research Method and Methodology in Education, SAGE Publication, 2017. |
|           |  |

#### 15 Hrs

#### 15 Hrs

15 Hrs

| 3         | Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age" 2016 |
|-----------|--|
| Reference | e Books:   |
| 1         | Dahlia K. Remler, Gregg G. Van Ryzin, Research Methods in Practice (Strategies for                       |
|           | Description and Causation), SAGE Publication, 2015.  |
| 2         | Uwe Flick, Introducing Research Methodology-A Beginer, SAGE, 2015.                                       |
| 3         | T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.                                    |
| Web Refe  | rences:  |
| 1.        | https://nptel.ac.in/courses/109103024/40   |
| 2.        | https://nptel.ac.in/syllabus/107108011/  |
| 3.        | http://textofvideo.nptel.ac.in/121106007/lec26.pdf   |
| 4.        | https://www.wipo.int/edocs/pubdocs/en/intproperty/958/wipo_pub_958_3.pdf                                 |

|                         | Continuous Assessn      | nent  |                                   |                             |       |
|-------------------------|-------------------------|-------|-----------------------------------|-----------------------------|-------|
| Formative<br>Assessment | Summative<br>Assessment | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
| 80                      | 120                     | 200   | 40                                | 60                          | 100   |

| Assessment Methods & Levels (based on Blooms' Taxonomy) |  |  |                        |  |  |  |  |  |  |  |  |  |
|---|--|--|------------------------|--|--|--|--|--|--|--|--|--|
| Formative   | Formative Assessment based on Capstone Model |  |                        |  |  |  |  |  |  |  |  |  |
| Course<br>Outcome                                       | Bloom's<br>Level                             | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |  |  |  |  |  |  |
| C202.1  | Understand                                   | Quiz   | 20                     |  |  |  |  |  |  |  |  |  |
| C202.2  | Analyze                                      | Assignment   | 20                     |  |  |  |  |  |  |  |  |  |
| C202.3  | Apply  | Caso Study   | 20                     |  |  |  |  |  |  |  |  |  |
| C202.4  | Analyze                                      |  | 20                     |  |  |  |  |  |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |  |             |  |  |  |  |  |  |  |  |
|--|-------------------------|--|-------------|--|--|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | mative Assessment (24%) End Semeste<br>[120 Marks] (60 |             |  |  |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]                                      | [100 marks] |  |  |  |  |  |  |  |  |
| Remember   | 10                      | 10   | 10          |  |  |  |  |  |  |  |  |
| Understand   | 30                      | 40   | 30          |  |  |  |  |  |  |  |  |
| Apply  | 30                      | 20   | 30          |  |  |  |  |  |  |  |  |
| Analyse  | 30                      | 30   | 30          |  |  |  |  |  |  |  |  |
| Evaluate   | -                       | -  | -           |  |  |  |  |  |  |  |  |
| Create   | -                       | -  | -           |  |  |  |  |  |  |  |  |

| Assessm       | Assessment based on Continuous and End Semester Examination |                                 |               |                                |                                 |             |  |  |  |  |  |
|---------------|---|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|--|--|--|--|
|               | End   |                                 |               |                                |                                 |             |  |  |  |  |  |
|               | Semester<br>Examination                                     |                                 |               |                                |                                 |             |  |  |  |  |  |
| SA 1          | FA 1 (4   | 0 Marks)                        | SA 2          | FA 2 (40 Marks)                |                                 | (60%)       |  |  |  |  |  |
| (60<br>Marks) | Component<br>- I<br>(20 Marks)                              | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |  |  |  |  |

| No. of<br>the CO | РО<br>1 | РО<br>2 | РО<br>3 | PO<br>4 | РО<br>5 | PO<br>6                      | РО<br>7 | PO<br>8 | РО<br>9 | РО<br>10 | РО<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|---------|---------|---------|---------|---------|------------------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| C519.1           | 3       | 3       | 3       | 2       |         | 1                            | 1       |         |         |          |          | 2        |          | 3        |          |
| C519.2           | 3       | 2       | 2       | 1       |         |                              |         |         |         |          |          |          |          | 2        |          |
| C519.3           | 3       | 2       | 1       |         |         |                              |         |         |         |          |          | 3        |          | 2        |          |
| C519.4           | 3       | 2       | 2       | 1       |         |                              |         |         |         |          |          |          |          | 2        |          |
| 1                | Reas    | sonat   | oly Ag  | greed   | 2       | Moderately Agreed 3 Strongly |         |         |         | y Agree  | ed       |          |          |          |          |

| 22PE520   | Advanced Microcontrollers Based System 3 |   |          |  |  |  |
|-----------|--|---|----------|--|--|--|
| Nature of | Course                                   | D (Theory Application)  |          |  |  |  |
| Course P  | re-requisites                            | Microprocessor and Microcontroller                              |          |  |  |  |
| Course O  | bjectives:                               |   |          |  |  |  |
| 1         | To study Archit                          | ecture of microcontroller like Intel 8051 & PIC microcontroller |          |  |  |  |
| 2         | To study the ba                          | asic concepts of Arduino Uno and Raspberry Pi.                  |          |  |  |  |
| 3         | To develop sk                            | ill in simple applications development with programming 80      | 51, PIC, |  |  |  |
| 5         | Arudino Uno ar                           | nd Raspberry Pi.  |          |  |  |  |
| Course Ou | tcomes:                                  |   |          |  |  |  |
| Upon com  | pletion of the o                         | course, students shall have ability to                          |          |  |  |  |
| C520.1    | Write program                            | me in 8051 microcontroller to develop an different applications | 3 [A]    |  |  |  |
| C520.2    | Interpret PIC                            | microcontroller and its architecture                            | [U]      |  |  |  |
| C520.3    | Write program                            | in PIC microcontroller for interface the peripheral devices     | [7]      |  |  |  |
|           | andtheir applications.                   |   |          |  |  |  |
| C520.4    | Illustrate the b                         | asic concepts of Arduino.                                       | [U]      |  |  |  |
| C520.5    | Infer the basic                          | programming concepts of Raspberry Pi and applications.          | [AP]     |  |  |  |
| Course C  | ontents:                                 |   |          |  |  |  |
|           |  |   |          |  |  |  |

#### Module 1: 8051 Microcontroller and its applications

Basic organization - 8051 CPU structure - Register file - Interrupts - Timers - Port circuits - Instruction set - Timing diagram - Addressing modes - Simple Programs. Case study: Real Time clock - DC Motor Speed Control - Generation of Gating Signals for Converters and Inverters - Frequency Measurement - Temperature Control.

#### Module 2: PIC Microcontroller and its applications

Introduction - Architecture - Instruction set - Addressing modes - Memory organization - Assembly Language programming - simulation using Integrated Development Environment - Programming of I/O ports - Timers and its programming - Interrupt programming- analog-to-digital converter module - I<sup>2</sup>C Interfacing - UART- PWM- Synchronous Serial Port Module - Compare Capture PWM module. Case Study: Stepper motor interfacing - Closed loop control of servo motor.

#### Module 3 Arduino and Raspberry Pi

Arduino program - setup and loop functions, main interface of an Arduino through its pins, UART communication protocol to gain controllability and observability, Serial library to communicate with the Arduino through the serial monitor. Transducer Interface - Sensor interface, LCD interface, Servo Control, PWM signal generation concepts, GPS, GSM interface with Arduino Uno. Introduction about raspberry Pi family, OS installation, GPIO, UART, C programming in Raspberry Pi, basic computation in raspberry Pi, Python scripts based accessing of GPIO pins in raspberry Pi.

| Text Books:   | lition   |
|---|----------|
|   | lition   |
| Richard Blum, "Arduino Programming in 24 Hours", Pearson Education, 1" ec           | anion,   |
| 2015.   |          |
| Simon Monk, "Raspberry Pi Cookbook: Software and HardwareSolutions"                 | O'Reilly |
| 2 Reprints; Second edition 2016.  |          |
| 3 John .B.Peatman , " Design with PIC Microcontroller , Prentice hall, 2003.        |          |
| Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Cor           | troller  |
| and Embedded Systems', PHI Pearson Education, 5 <sup>th</sup> Indian reprint, 2003. |          |
| Reference Books:  |          |
| Arduino Cookbook, 2nd Edition Recipes to Begin, Expand, and Enhance Yo              | ur       |
| ProjectsMichael Margolis Publisher: O'Reilly Media, 2011.                           |          |

## 15 Hrs

# 15 Hrs

15 Hrs

| 2        | Simon Monk, "Programming Arduino Getting Started with Sketches", McGraw-Hill  |  |  |  |  |  |
|----------|---|--|--|--|--|--|
| 2        | Education Tab, 2012.  |  |  |  |  |  |
| 2        | Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, |  |  |  |  |  |
| 3        | Prentice Hall of India, New Delhi , 2007.                                     |  |  |  |  |  |
| Web Refe | Web References:   |  |  |  |  |  |
| 1.       | https://www.coursera.org/learn/raspberry-pi-platform                          |  |  |  |  |  |
| 2.       | https://www.coursera.org/learn/arduino-platform                               |  |  |  |  |  |
| 3.       | https://www.coursera.org/learn/interface-with-arduino                         |  |  |  |  |  |

| Formative Summative<br>Assessment Assessment |     | Total | Total<br>Continuous<br>Assessment | Total<br>Continuous<br>Assessment |     |
|--|-----|-------|-----------------------------------|-----------------------------------|-----|
| 80   | 120 | 200   | 40                                | 60                                | 100 |

| Assessment Methods & Levels (based on Blooms' Taxonomy)   |               |                       |    |  |  |  |  |
|---|---------------|-----------------------|----|--|--|--|--|
| Formative   | Assessment ba | sed on Capstone Model |    |  |  |  |  |
| Course<br>OutcomeBloom's<br>LevelAssessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment)FA (16%<br>[80 Mar |               |                       |    |  |  |  |  |
| C520.1  | Analyze       | Online Quiz           | 20 |  |  |  |  |
| C520.2  | Understand    | Class Presentation    | 20 |  |  |  |  |
| C520.3  | Analyze       | Group Assignment 20   |    |  |  |  |  |
| C520.4  | Understand    |                       | 20 |  |  |  |  |
| C520.5  | Apply         | Case Study            | 20 |  |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                   |  |  |  |  |
|--|-------------------------|-------------------------|-----------------------------------|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 M | essment (24%)<br>larks] | End Semester Examination<br>(60%) |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                       |  |  |  |  |
| Remember   | 20                      | 20                      | 20                                |  |  |  |  |
| Understand   | 20                      | 20                      | 20                                |  |  |  |  |
| Apply  | 30                      | 30                      | 30                                |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                                |  |  |  |  |
| Evaluate   | -                       | -                       | -                                 |  |  |  |  |
| Create   | -                       | -                       | -                                 |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |                       |                                |                                 |                         |  |
|---|--------------------------------|---------------------------------|-----------------------|--------------------------------|---------------------------------|-------------------------|--|
|   | End                            |                                 |                       |                                |                                 |                         |  |
| CA 1 : 100 Marks CA 2 : 100 Marks                           |                                |                                 |                       |                                |                                 | Semester<br>Examination |  |
| SA 1  | FA 1 (40 Marks)                |                                 | SA 2                  | FA 2 (40 Marks)                |                                 | (60%)                   |  |
| (60<br>Marks)   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | SA 2<br>(60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks]             |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5           | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9         | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|-------------------|---------|---------|---------|-----------------|----------|----------|----------|----------|----------|----------|
| C520.1           | 3                 | 3       | 2       | 2       |                   |         |         |         |                 |          |          | 1        | 3        |          |          |
| C520.2           | 1                 | 1       |         |         |                   |         |         |         |                 |          |          | 1        | 2        |          | 2        |
| C520.3           | 3                 | 3       | 2       | 2       |                   |         |         |         |                 |          |          | 1        | 3        |          |          |
| C520.4           | 1                 | 1       |         |         |                   |         |         |         |                 |          |          | 1        | 2        |          | 2        |
| C520.5           | 3                 | 2       | 1       | 1       |                   |         |         |         |                 | 1        |          | 2        | 3        |          |          |
| 1                | Reasonably Agreed |         |         | 2       | Moderately Agreed |         |         | 3       | Strongly Agreed |          |          |          |          |          |          |

# OPEN ELECTIVE COURSE

1

| 22PE001  | Waste to Energy 3/0/0/3  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|
| Nature of  | Course G (Theory)  |  |  |  |  |  |  |  |
| Course P   | re-requisites  | Nil  |  |  |  |  |  |  |
| Course O   | bjectives:   |  |  |  |  |  |  |  |
| 1  | 1 To expose the types of wastes and energy conversion methodologies from wastes.                         |  |  |  |  |  |  |  |
| 2  | To gain knowledge on the construction and operation of biogas and biomass gasification.                  |  |  |  |  |  |  |  |
| 3  | To analyze the   | conversion methodologies of biogas and biomass to energy.  |  |  |  |  |  |  |
| Course Ou  | tcomes:  |  |  |  |  |  |  |  |
| Upon com   | pletion of the c   | ourse, students shall have ability to  |  |  |  |  |  |  |
| C001.1   | Infer various ty   | pes of wastes and their conversion methodologies.  | [U]  |  |  |  |  |  |
| C001.2   | Interpret the co<br>Combustion.  | onstruction and operation of biomass gasification and  | [U]  |  |  |  |  |  |
| C001.3   | Analyze on the   | e various methods to convert the biomass in to energy.   | [A]  |  |  |  |  |  |
| C001.4   | Develop biog<br>efficiency.  | gas gasification and combustion techniques for improved  | [AP]   |  |  |  |  |  |
| C001.5   | Analyze on the   | e various methods to convert the biogas in to energy.  | [A]  |  |  |  |  |  |
| Course C   | ontents:   | 5 5,   |  |  |  |  |  |  |
| Module 1:  | Introduction t   | o Energy from Waste  | 15 Hrs   |  |  |  |  |  |
| Classificat<br>devices-In<br>waste   | ion of waste as cinerators, gasif  | fuel-Agro based, Forest residue, Industrial waste - MSW Con<br>fication, anaerobicdigestion, fermentation, Pyrolysis, Introduct  | version<br>on to e-                                |  |  |  |  |  |
| construction<br>arrangement<br>Combusion<br>combustor  | on and operation<br>ent and electrican: Biomass st<br>rs, Types, inclin                                  | n - Gasifier burner arrangement for thermal heating - Gasifi<br>al power- Equilibrium and kinetic consideration in gasifier of<br>oves - Improved chullahs, types, some exotic designs, F<br>ed grate combustors, Fluidized bed combustors, Design, co | er engine<br>operation.<br>fixed bed<br>nstruction |  |  |  |  |  |
|  |  | of all the above biomass combustors.   |  |  |  |  |  |  |
| Module 3 Biogas 15 Hrs<br>Properties of biogas (Calorific value and composition) - Biogas plant technologyand status -<br>Bio energy system - Design and constructional features - Biomass resources and their<br>classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion<br>- biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion<br>- Types of biogas Plants - Applications - Alcohol production from biomass - Bio diesel production<br>- Urban waste to energy conversion - Biomass energy programme in India. |  |  |  |  |  |  |  |  |
| Text Bool  | (S:  |  |  |  |  |  |  |  |
| 1  | Gary C. Youn   | g "Municipal Solid Waste to Energy Conversion Processes:   | 10   |  |  |  |  |  |
| 2  | Robert Green   | "From Waste to Energy". Cherry Lake Pub. 2009.   | 10.  |  |  |  |  |  |
| 3  | 3 Dieter D. and Angelika.S, "Biogas from waste and renewable resources" Wiley-<br>Vch Publication, 2010. |  |  |  |  |  |  |  |
| 4 Marc Rogoff Francois Screve, "Waste to Energy, Technologies and<br>ProjectImplementation", 2011.   |  |  |  |  |  |  |  |  |
| Reference  | e Books:   |  |  |  |  |  |  |  |
| 1  | Branchini, Lisa  | a, "Waste-to-Energy,Advanced Cycles and New Design Co  | oncepts  |  |  |  |  |  |
| 2  | Khandelwal. K  | . C. and Mahdi, S. S.,"Biogas Technology - A Practical Hand  | Book"  |  |  |  |  |  |
|  | · · · · · · · · · · · · · · · · · ·  | , ,  |  |  |  |  |  |  |

|          | Vol. I & II, Tata McGraw Hill Publishing Co. Ltd. 2003.                         |  |  |  |  |  |
|----------|---|--|--|--|--|--|
| 3        | Challal, D. S., "Food, Feed and Fuel from Biomass", IBH Publishing Co. Pvt.     |  |  |  |  |  |
|          | Ltd., 2007.   |  |  |  |  |  |
| Λ        | C. Y. WereKo-Brobby and E. B. Hagan, "Biomass Conversion and Technology",       |  |  |  |  |  |
| 4        | John Wiley & Sons, 2007.  |  |  |  |  |  |
| Web Refe | Web References:   |  |  |  |  |  |
| 1.       | https://swayam.gov.in/course/4365-waste-to-energy-conversion                    |  |  |  |  |  |
| 2.       | https://www.classcentral.com/tag/waste-management                               |  |  |  |  |  |
| 3.       | https://www.un-ihe.org/online-course-solid-waste-management                     |  |  |  |  |  |
| 4.       | https://www.cseindia.org/certificate-course-on-integrated-waste-management-8797 |  |  |  |  |  |

| Formative Summative<br>Assessment Assessment |     | Total | Total<br>Continuous<br>Assessment | End Semester<br>Examination | Total |
|--|-----|-------|-----------------------------------|-----------------------------|-------|
| 80   | 120 | 200   | 40                                | 60                          | 100   |

| Assessme          | Assessment Methods & Levels (based on Blooms' Taxonomy) |  |                        |  |  |  |
|-------------------|---|--|------------------------|--|--|--|
| Formative         | Assessment ba   | sed on Capstone Model  |                        |  |  |  |
| Course<br>Outcome | Bloom's<br>Level  | Assessment Component (Choose and map<br>components from the list - Quiz, Assignment,<br>Case Study, Seminar, Group Assignment) | FA (16%)<br>[80 Marks] |  |  |  |
| C001.1            | Understand  | Quiz   | 20                     |  |  |  |
| C001.2            | Understand  | Presentation   | 20                     |  |  |  |
| C001.3            | Analyze   | Assignment   | 20                     |  |  |  |
| C001.4            | Apply   |  | 20                     |  |  |  |
| C001.5            | Analyze   | Case Study   | 20                     |  |  |  |

| Assessment based on Summative and End Semester Examination |                         |                         |                                |  |  |  |  |  |  |  |
|--|-------------------------|-------------------------|--------------------------------|--|--|--|--|--|--|--|
| Bloom's Level  | Summative Ass<br>[120 N | essment (24%)<br>larks] | End Semester Examination (60%) |  |  |  |  |  |  |  |
|  | CIA1 : [60 Marks]       | CIA2 : [60 Marks]       | [100 Marks]                    |  |  |  |  |  |  |  |
| Remember   | 20                      | 20                      | 20                             |  |  |  |  |  |  |  |
| Understand   | 20                      | 20                      | 20                             |  |  |  |  |  |  |  |
| Apply  | 30                      | 30                      | 30                             |  |  |  |  |  |  |  |
| Analyse  | 30                      | 30                      | 30                             |  |  |  |  |  |  |  |
| Evaluate   | -                       | -                       | -                              |  |  |  |  |  |  |  |
| Create   | -                       | -                       | -                              |  |  |  |  |  |  |  |

| Assessment based on Continuous and End Semester Examination |                                |                                 |               |                                |                                 |             |  |  |  |  |  |
|---|--------------------------------|---------------------------------|---------------|--------------------------------|---------------------------------|-------------|--|--|--|--|--|
|   | End                            |                                 |               |                                |                                 |             |  |  |  |  |  |
|   | CA 1 : 100 Ma                  | arks                            | CA 2 : 100 Ma | Semester<br>Examination        |                                 |             |  |  |  |  |  |
| SA 1<br>(60<br>Marks)                                       | FA 1 (4                        | 0 Marks)                        | SA 2          | FA 2 (4                        | (60%)                           |             |  |  |  |  |  |
|   | Component<br>- I<br>(20 Marks) | Component<br>- II<br>(20 Marks) | (60<br>Marks) | Component<br>- I<br>(20 Marks) | Component -<br>II<br>(20 Marks) | [100 Marks] |  |  |  |  |  |

| No. of<br>the CO | РО<br>1           | РО<br>2 | РО<br>3 | РО<br>4 | РО<br>5           | РО<br>6 | РО<br>7 | PO<br>8 | РО<br>9         | PO<br>10 | PO<br>11 | PO<br>12 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|------------------|-------------------|---------|---------|---------|-------------------|---------|---------|---------|-----------------|----------|----------|----------|----------|----------|----------|
| C001.1           | 3                 | 3       | 3       | 2       |                   | 1       | 1       |         |                 |          |          | 2        |          | 3        |          |
| C001.2           | 3                 | 2       | 2       | 1       |                   |         |         |         |                 |          |          |          |          | 2        |          |
| C001.3           | 3                 | 2       | 1       |         |                   |         |         |         |                 |          |          | 3        |          | 2        |          |
| C001.4           | 3                 | 2       | 2       | 1       |                   |         |         |         |                 |          |          |          |          | 2        |          |
| C001.5           | 3                 | 2       | 1       |         |                   |         |         |         |                 |          |          | 3        |          | 2        |          |
| 1                | Reasonably Agreed |         |         | 2       | Moderately Agreed |         |         | 3       | Strongly Agreed |          |          |          |          |          |          |