

**Academic Program: UG**

**Academic Year 2025-26 Syllabus**

**VII & VIII Semester B. E.**



SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF  
ENGINEERING & TECHNOLOGY,  
DHARWAD – 580 002

**An Autonomous Institution Approved by AICTE & Affiliated to VTU, Belagavi**  
Department Accredited by NBA under Tier-1 (July 2022-June 2025)

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It is certified that the scheme and syllabus for VII & VIII semester B.E. in Electrical & Electronics Engineering is recommended by the Board of Studies of Electrical and Electronics Engineering Department and approved by the Academic Council, SDM College of Engineering & Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2025-26 till further revision.

Principal

Chairman BoS & HoD

**SDM College of Engineering & Technology, Dharwad**  
**Department of Electrical & Electronics Engineering**  
(*Our motto: Professional Competence with Positive Attitude*)

**College Vision and Mission**

**Vision**

To develop competent professionals with human values

**Mission**

- To have contextually relevant Curricula.
- To promote effective Teaching Learning Practices supported by Modern Educational Tools and Techniques.
- To enhance Research Culture
- To involve Industrial Expertise for connecting classroom content to real life situations.
- To inculcate Ethics and impart soft-skill leading to overall Personality Development.

**QUALITY POLICY:**

In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

**CORE VALUES:**

Competency  
Commitment  
Equity  
Team work and  
Trust

**DEPARTMENT VISION AND MISSION**

**Vision:**

To develop globally acceptable Electrical and Electronics Engineering professionals with human values.

**Mission:**

- Adopting the state of the art curricula
- Practicing effective and innovative teaching-learning methodologies
- Initiating complementary learning activities to enhance competence
- Inculcating positive attitude and commitment to society.

**Program Educational Objectives (PEOs)**

- I. To impart the domain knowledge and soft skills to secure employment or become entrepreneur or pursue higher studies.
- II. To provide training for teamwork, leadership qualities, lifelong learning and adaptability to achieve professional growth.
- III. To develop sense of positive attitude and practice ethics to contribute positively to the society as a responsible citizen.

**POs and PSOs**

- PO 1 Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
- PO 2 Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO 3 Design/Development of solutions:** Design solutions for complex 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.
- PO 4 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.
- PO 5 Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- PO 6 The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO 7 Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO 8 Ethics:** Apply ethical principles and commit to professional ethics responsibilities and norms of the engineering practice.

- PO 9 Individual and Team work:** Function effectively as an individual and as a member or leader in diverse teams and individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO 10 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, and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO 11 Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and 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.
- PO 12 Life-long Learning:** long learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
- PSO 1** Enhancement of professional competence in cutting edge domain through value addition activities.
- PSO 2** Ability to demonstrate the skill of carrying out operation and Maintenance of electrical distribution system effectively.
- PSO 3** Design and implement the electronic circuits/programs for practical applications.

## SDMCET: Syllabus

### SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD Electrical & Electronics Engineering Department VII Semester

#### Scheme of Teaching and Examinations 2025-26

| Sl. No                      | Course | Course code | Course Title                                        | TD/PSB | Teaching Hrs./Week |          |                       | Examination         |           |           |             | Credits |
|-----------------------------|--------|-------------|-----------------------------------------------------|--------|--------------------|----------|-----------------------|---------------------|-----------|-----------|-------------|---------|
|                             |        |             |                                                     |        | Lecture            | Tutorial | Practical/<br>Drawing | Duration in<br>Hrs. | CIE Marks | SEE Marks | Total Marks |         |
|                             |        |             |                                                     |        |                    |          |                       |                     |           |           |             |         |
| 1                           | PCC    | 22UEEC700   | Computer Application to Power Systems               | EEE    | 4                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 4       |
| 2                           | PEC    | 22UEEE7XX   | Program Elective Course -IV                         | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
| 3                           | PEC    | 22UEEE7XX   | Program Elective Course -V                          | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
| 4                           | OEC    | 22UEEO7XX   | Open Elective Course -II                            | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
| 5                           | PCCL   | 22UEEL701   | Relay, High Voltage and Power System Simulation Lab | EEE    | 0                  | 0        | 2                     | 03                  | 50        | 50        | 100         | 1       |
| 6                           | PROJ   | 22UEEL702   | Major Project-I                                     | EEE    | 0                  | 0        | 12                    | 03                  | 50        | 50        | 100         | 6       |
| Total                       |        |             |                                                     |        |                    |          |                       |                     |           |           | 600         | 20      |
| Program Elective Course -IV |        |             |                                                     |        |                    |          |                       |                     |           |           |             |         |
|                             | PEC-IV | 22UEEE721   | Industrial Utilization of Electric Power            | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
|                             | PEC-IV | 22UEEE722   | Modern Trends in Transmission Systems               | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
| Program Elective Course -V  |        |             |                                                     |        |                    |          |                       |                     |           |           |             |         |
|                             | PEC-V  | 22UEEE731   | AI and its Applications to Power Systems            | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
|                             | PEC-V  | 22UEEE732   | VLSI Circuits and Design                            | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
| Open Elective Course-II     |        |             |                                                     |        |                    |          |                       |                     |           |           |             |         |
|                             | OEC-II | 22UEEO741   | Electric Vehicles                                   | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |
|                             | OEC-II | 22UEEO742   | Energy Storage and Management                       | EEE    | 3                  | 0        | 0                     | 03                  | 50        | 100       | 100         | 3       |

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. PEC: Program elective course, OEC: Open elective course, PROJ: Project. TD: Teaching department, PSB: Paper setting Board.

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum numbers of students' strength for offering Open Elective Course are as prescribed by the DAP.

**Open Elective Courses (OEC):** Students belonging to a particular stream of Engineering and Technology are entitled to opt for the open electives offered by their parent Department and other departments provided that they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course are as prescribed by the DAP.

**Major Project-I:** The objective of the project work is to encourage development of independent learning, innovative attitude, communication skills, organisation, time management, presentation skills, team work, punctuality, setting and meeting deadlines. In Major project the students are expected to identify the state-of-the-art technology in their domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The project shall consist of a team of students not more than 2-4. Each batch shall be assigned with a faculty member. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE. There is SEE, a viva voce examination which shall be examined by two examiners constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation, communication skill and question and answer session.

**AICTE activity point:** Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the program. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fails to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

**SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD**

**Electrical & Electronics Engineering Department**

**VIII Semester**

**Scheme of Teaching and Examinations 2025-26**

| Sl. No | Course      | Course code | Course Title                        | TD/PSB | Teaching Hrs./Week |          |                       | Examination      |           |           |             | Credits |
|--------|-------------|-------------|-------------------------------------|--------|--------------------|----------|-----------------------|------------------|-----------|-----------|-------------|---------|
|        |             |             |                                     |        | Lecture            | Tutorial | Practical/<br>Drawing | Duration in Hrs. | CIE Marks | SEE Marks | Total Marks |         |
|        |             |             |                                     |        | L                  | T        | P                     |                  |           |           |             |         |
| 1      | TS          | 22UEEL800   | Technical Seminar/Independent Study | EEE    | 0                  | 0        | 2                     | -                | 50        | -         | 50          | 1       |
| 2      | PROJ or INT | 22UEEL801   | Major Project-II/Internship         | EEE    | 12 Weeks           |          |                       | 03               | 50        | 50        | 100         | 10      |
| 3      | INT         | 22UEEL802   | Summer Internship                   | EEE    | 4 Weeks            |          |                       | 03               | 50        | 50        | 100         | 3       |
| Total  |             |             |                                     |        |                    |          |                       |                  |           |           | 250         | 14      |

L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation., TD: Teaching department, PSB: Paper setting Board.

**Technical Seminar/Independent study (TS):** Students are expected to learn how to conduct a literature survey to identify the state-of-the-art technology in their chosen engineering domain. They are required to select an emerging topic beyond the syllabus relevant to their branch of study, understand the concept, analyse it, and present it effectively with technical innovations or novel work in a 15–20 minute session, followed by a 5-minute question and answers with their classmates and faculty. Additionally, students must develop effective communication skills and understand the modalities of technical interactions. They are required to submit a seminar report following the format provided by the DUGC. The technical seminar is evaluated for CIE based on the rubrics prescribed by the DUGC.

**Summer Internship:** Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship should be completed over a period of four weeks during the summer vacation after the IV or VI semester and must be completed before the VII semester. Students are required to prepare a report on the work carried out

during the internship and submit both the report and the internship certificate during the VIII semester. The internal faculty will monitor student performance and award CIE marks in the VIII semester. Additionally, there will be a SEE, in which students must present their work before a panel of two examiners constituted by the HoD during the SEE of the VIII semester.

**Major Project-II:** This project work is intended for students who do not undertake an internship. The objective of the project is to foster independent learning, an innovative mindset, communication skills, organization, time management, presentation skills, teamwork, punctuality, and the ability to set and meet deadlines. In this project, students are expected to conduct an extensive literature survey to identify state-of-the-art technology in their domain of interest, select a topic from an emerging area relevant to their branch or an interdisciplinary field, and define the problem for their project work. Each project team shall consist of 2 to 4 students and will be assigned a faculty mentor. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE, along with marks awarded by the faculty guide. A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation, communication skill and question and answer session.

**Internship:** The internship is intended for students who do not undertake a project. Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship shall be for a duration of 12 weeks during the VIII semester, either through placement or on an individual basis. Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE. A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the work carried out, report, project presentation, communication skill and question and answer session.

**AICTE activity point:** Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the program. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fails to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

**VII Semester**

**22UEEC700      Computer Application to Power Systems      (4 - 0 - 0) 4**

**Contact Hrs.: 52**

**Course learning objectives (CLOs):**

The students are expected to learn about the formation of different matrices to represent the power system network and load frequency control techniques. It is required to understand the load flow studies and use of various numerical techniques for the same. The student should get exposure to optimal distribution of load and economic operation. Further, must know to carry out steady and transient states analysis using different techniques.

**Course Outcomes (COs):**

| <b>Description of the Course Outcome:</b><br>At the end of the course the student will be able to: |                                                                                                                 | <b>Mapping to PO's (1 to12)/ PSO's (1 to 3)</b> |                           |                         |
|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------|-------------------------|
|                                                                                                    |                                                                                                                 | <b>Substantial Level (3)</b>                    | <b>Moderate Level (2)</b> | <b>Slight Level (1)</b> |
| CO-1                                                                                               | Describe importance of computer techniques in power system, form bus impedance and admittances matrices.        | 1, 2                                            |                           |                         |
| CO-2                                                                                               | Model single area and two area systems and analyse steady state and dynamic response of load frequency control, | 1, 2                                            |                           |                         |
| CO-3                                                                                               | Analyse load flow using different techniques                                                                    | 1, 2                                            |                           |                         |
| CO-4                                                                                               | Determine Optimal distribution of load between the units with and without transmission line loss                | 1, 2                                            |                           |                         |
| CO-5                                                                                               | Analyse Transient stability studies using different methods.                                                    | 1, 2                                            |                           |                         |

| <b>PO's</b>          | <b>PO-1</b> | <b>PO-2</b> | <b>PO-3</b> | <b>PO-4</b> | <b>PO-5</b> | <b>PO-6</b> | <b>PO-7</b> | <b>PO-8</b> | <b>PO-9</b> | <b>PO-10</b> | <b>PO-11</b> | <b>PO-12</b> | <b>PSO-1</b> | <b>PSO-2</b> | <b>PSO-3</b> |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|
| <b>Mapping Level</b> | 3.0         | 3.0         |             |             |             |             |             |             |             |              |              |              |              |              |              |

**Prerequisites:** 1. Electrical Power generation, Distribution and Utilization.  
2. Power System Analysis and Stability.  
3. Switchgear and Protection.

**Contents:**

**Unit-I**

**Bus incidence matrix:** Primitive admittance matrix, Y-Bus by singular transformation. Algorithm for formation bus impedance matrix of single-phase system and numerical examples. **11 Hrs.**

**Unit-II**

**Power System Control:** Load frequency control, turbine speed governing system modelling. Block diagram representation of single area, steady state and dynamic response and Two-area load frequency control. **10 Hrs.**

**Unit-III**

**Load flow studies:** static load flow equations, types of buses, Gauss – Seidel iterative method using Y bus including PV bus, acceleration of convergence. Newton Raphson method in polar co-ordinates. Fast Decoupled load flow method. Representation of transformer fixed tap setting transformer, tap changing under load transformer. **11 Hrs.**

**Unit-IV**

**Economic operation of power system:** Optimal distribution of loads between units within a plant, Transmission loss as a function of plant generation, determination of loss coefficient and economic load dispatch with and without transmission line loss and numerical problems. **10 Hrs.**

**Unit-V**

**Transient stability studies:** Swing equation, Numerical solutions of differential equations: modified Euler's method, Runge Kutta IV order method Representation of synchronous machine for transient stability studies, load representation, Network performance equation and. Solution techniques with flowcharts. **10 Hrs.**

**Reference Books:**

- 1) Stag and El-Abiad, "Computer Methods in Power System Analysis", 1/e, McGraw Hill International, 1965
- 2) Uma Rao, "Computer Techniques and Models in Power Systems", I.K. International Publishing House Pvt. Ltd, 2007
- 3) Nagrath & Kothari, "Modern Power system Analysis", Tata McGraw Hill, 3/e, 2003
- 4) M. A. Pai, "Computer Techniques in Power System", Tata McGraw Hill, 2/e, 2014.

**22UEEL701 Relay, High Voltage and Power System Simulation Lab (0-0-2)1**
**Contact Hrs.: 26**
**Course Learning Objectives (CLOs):**

The students are expected to learn to independently handle the engineering practices in power systems, High voltage Engineering, Protection by conducting various experiments. They are to learn to formulate the circuit/system/experimental set up/work set up, operate the circuit, record the observations, tabulate the results indicating one specimen calculation, plot the curves if any and finally present the results/inference with justification and prepare laboratory report. Further they get exposure to the contemporary technological happenings and accordingly make use of software packages, tools to find the solution for power system related problems.

**Course Outcomes (COs):**

| Description of the Course<br>Outcome: At the end of the course the student will be able to: |                                                      | Mapping to PO's (1 to12)/ PSO's (1 to 3) |                    |                  |
|---------------------------------------------------------------------------------------------|------------------------------------------------------|------------------------------------------|--------------------|------------------|
|                                                                                             |                                                      | Substantial Level (3)                    | Moderate Level (2) | Slight Level (1) |
| CO-1                                                                                        | Form Y bus and calculate solution for swing equation | 9, POS-3                                 | 5                  | 4                |
| CO-2                                                                                        | Carry out load flow analysis, fault studies          | 9, POS-2                                 | 5                  | 4                |
| CO-3                                                                                        | Determine the characteristics of different relays    | 9, POS-2                                 | 5                  | 4                |
| CO-4                                                                                        | Determine breakdown strength of air and oil          | 9, POS-2                                 | 5                  | 4                |

| PO's          | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level |      |      |      | 1.0  | 2.0  |      |      |      | 3.0  |       |       |       |       | 3.0   | 3.0   |

**Prerequisites:** 1. Power system Analysis and Stability  
2. High Voltage Engineering  
3. Switchgear and Protection

**Contents:**

Minimum of 10 experiments to be conducted from the list given below.  
Expt.1. Y Bus formation by inspection/ singular transformation method.  
Expt.2. Swing equation by RK method.  
Expt.3. Load flow analysis by GS/NR method.

- Expt.4. Fault studies using power system toolbox.  
 Expt.5 Economic Load Dispatch.  
 Expt.6. Operating characteristics of electromechanical relay.  
 Expt.7. Operating characteristics of static relay.  
 Expt.8. Operating characteristics of Negative sequence relay.  
 Expt.9. Characteristics of % differential relay.  
 Expt.10. Operating characteristics of microprocessor based over-current relay.  
 Expt.11. Induction motor protection using numerical relay.  
 Expt.12. Break down strength of air by sphere gap method-demonstration.  
 Expt.13. Break down strength of transformer oil- demonstration.

**Reference Books/Material:**

- 1) Laboratory manuals.
- 2) Relevant books prescribed for the prerequisite subjects.

|                          |                          |                     |
|--------------------------|--------------------------|---------------------|
| <b>22UEEL702</b>         | <b>Major Project - I</b> | <b>(12 Weeks) 2</b> |
| <b>Contact Hrs.: 156</b> |                          |                     |

**Course Learning Objectives (CLOs):**

The students are expected to learn carrying out literature survey to locate the state-of-the-art technology while formulating/defining the project problem in engineering domain of their interest. The students are expected Select a topic from an emerging area relevant to electrical sciences and/or other relevant branches and define the problem for the project work. The material collection, survey, visits, data collection, preliminary design, analysis etc. is to be done in this phase. The same work will be continued in the next phase in VIII semester.

**Course Outcomes (COs):**

| <b>Description of the Course Outcome:</b><br>At the end of the course the student will be able to: |                                                                                                                | <b>Mapping to PO's (1 to12)/ PSO's (1 to 3)</b> |                           |                           |
|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------|---------------------------|
|                                                                                                    |                                                                                                                | <b>Substantial Level (3)</b>                    | <b>Moderate Level (2)</b> | <b>Slight Level (1)</b>   |
| CO-1                                                                                               | Carry out the literature survey to locate the state-of-the-art technology in his Engineering field of interest | 2                                               |                           | 4, 5, PSO-2, PSO-3        |
| CO-2                                                                                               | Define/formulate the problem for the project work                                                              | 2, 3                                            | 1, 4, 5                   | PSO-2, PSO-3              |
| CO-3                                                                                               | Design, develop, analyze, test, interpret the results, fabricate,                                              | 3                                               | 5                         | 7, 8, 9, 12, PSO-2, PSO-3 |

|      |                                                                                               |  |    |                        |
|------|-----------------------------------------------------------------------------------------------|--|----|------------------------|
|      | simulate, write code etc. relevant to his project work                                        |  |    |                        |
| CO-4 | Summarize the work into a project report and in all can carry out the technical work assigned |  | 10 | 6, 8, 11, PSO-2, PSO-3 |

| PO's          | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level | 2.0  | 3.0  | 3.0  | 1.5  | 1.6  | 1.0  | 1.0  | 1.0  | 1.0  | 2.0   | 1.0   | 1.0   | -     | 1.0   | 1.0   |

**Prerequisites:** Knowledge of both theory and practical courses learnt in all the previous semesters and relevant value-added information.

### Contents:

**Major project - I** in which the students are expected to locate the state of the art technology in his domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The material collection, survey, visits, data collection, preliminary design, analysis etc. is to be done in this phase. The project shall consist of a team of students not more than 4. Each batch shall be assigned with a guide. A committee consisting of minimum 3 faculty members of which guide is a member shall evaluate at the end for CIE. The weightage of marks shall be 50% for the committee and 50% for the guide. There is a SEE (viva voce) examination which shall be examined by two internal examiners appointed by COE based on the suggestions by the respective HoD.

### General Instructions to Students:

1. Students are expected to perform extensive literature survey, identify problem statements, and prepare synopsis in consultation with project guide/supervisor. Students are expected to submit synopsis- Initial (Registration Phase-1) approved by project guide, to the project coordinator as per the schedule notified. A copy is to be maintained with students and the guide. This registration/ Initial synopsis contains the description of the project concept created and acts as a base line for design and Implementation of the system.
2. Notification/schedules and evaluation procedures will be sent to all students in the Google groups created in the department.

3. Evaluation of problem statement/synopsis-Initial (registration phase-1), Literature Survey and SRS (Requirement Analysis Phase-1) are done in the 7th semester.

| Sl. No. | Parameters for Assessment                                   | % of weightage for CIE and SEE |
|---------|-------------------------------------------------------------|--------------------------------|
| P1      | Project Synopsis/ Proposal Evaluation                       | 15                             |
| P2      | Literature survey/Technology used / Architectural design    | 15                             |
| P3      | Requirement Analysis (SRS)                                  | 15                             |
| P4      | Design methodology/Demonstration of tool used for designing | 10                             |
| P5      | Implementation modules                                      | 15                             |
| P6      | Discussion of test cases /Project demonstration             | 15                             |
| P7      | Project Report (phase-1 and Phase-2)                        | 10                             |
| P8      | Paper Publication / Presentation                            | 05                             |

**Reference materials/books:**

1. Engineering books.
2. Journals.
3. Manuals and data sheets.
4. Software packages.
5. Previous project reports.
6. Product information brochures.
7. Interaction with academia and industrial experts.
8. Internet.

**22UEEE721      Industrial Utilization of Electric Power      (3 - 0 - 0) 3**

**Contact Hrs.: 39**

**Course Learning Objectives (CLOs):**

The students are expected to learn the different electric drives, their selection, and dynamics. Further, they are required to evaluate their performance under transient and steady state conditions. They are required to know the performance of specific drives like DC motors, Induction motors and Synchronous motors, their suitability and applications in various industries. It is expected that they are to be aware of new control mechanisms of industrial drives.

**Course Outcomes (COs):**

| <b>Description of the Course Outcome:</b><br>At the end of the course the student will be able to: |                                                                                                                                                 | <b>Mapping to PO's (1 to 12)/ PSO's (1 to 3)</b> |                           |                         |
|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|---------------------------|-------------------------|
|                                                                                                    |                                                                                                                                                 | <b>Substantial Level (3)</b>                     | <b>Moderate Level (2)</b> | <b>Slight Level (1)</b> |
| CO-1                                                                                               | Understand the concepts of electrical drives system and dynamics (both transient and steady state) and apply this knowledge to solve numerical. | 2                                                |                           |                         |
| CO-2                                                                                               | Determine the motor rating selection based on the duty and thermal model for heating and cooling.                                               | 2                                                |                           |                         |
| CO-3                                                                                               | Analyze the DC Motor Drive characteristics and their control through power electronic systems and apply this knowledge to solve numerical.      | 2                                                |                           |                         |
| CO-4                                                                                               | Analyze the Induction Motor Drive characteristics and their control through power electronic systems and hence be able to solve numerical.      | 2                                                |                           |                         |
| CO-5                                                                                               | Analyze the Synchronous Motor Drive. Also understand the process involved in different mills.                                                   | 2                                                |                           |                         |

| PO's          | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level |      | 3.0  |      |      |      |      |      |      |      |       |       |       |       |       |       |

**Prerequisites:** 1. AC and DC Machines. 2. Power Electronics.

**Contents:**

### **Unit-I**

**Introduction to Electrical drives & its dynamics:** Parts of electrical drives; Merits & Demerits; choice of electrical drives; status of dc and ac drives. Dynamics of electrical drives; Fundamental torque equation; speed torque conventions; four quadrant operation. Equivalent values of drive parameters. Components of load torques; nature and classification of load torques. Calculation of time and energy loss in transient operations; Steady state stability.

**08 Hrs.**

### **Unit-II**

**Selection of motor power rating:** Design of heating elements, thermal model of motor for heating and cooling, Classes of motor duty, determination of motor rating for Continuous duty, fluctuating duty, short time duty and periodic duty.

**08 Hrs.**

### **Unit-III**

**D C Motor Drives:** Starting; Braking; Transient analysis. Single phase fully controlled rectifier control of dc separately excited motor. Three phase fully controlled rectifier control of dc separately excited motor. Multi quadrant operation of dc separately excited motor fed from fully controlled rectifier. Rectifier control of dc series motor. Chopper control of separately excited dc motor. Chopper control of series motor.

**08 Hrs.**

### **Unit-IV**

**Induction motor Drives:** Operation with unbalanced source voltage and single phasing; Starting; Braking; Transient analysis. Stator voltage control; Variable voltage, frequency control from voltage sources; Voltage source inverter control; Current source inverter control, Rotor resistance control, Slip power recovery, Speed control of single-phase induction motors.

**08 Hrs.**

### **Unit-V**

**Synchronous motor Drives:** Synchronous motor Drive Basics; Operation from fixed frequency supply; Synchronous motor variable speed drives; Variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thyristor inverter.

**Industrial Drives:** Rolling mill drives; Cement mill drives; Paper mill drives; Textile mill drives.

**07 Hrs.**

**Reference Books:**

- 1) G.K. Dubey, "Fundamentals of Electrical Drives", 2 Edition, 5/e reprint Narosa publishing house Chennai, 2002.
- 2) N.K. De and P.K. Sen, "Electrical Drives", PHI, 2007.
- 3) S.K. Pillai, "A first course on electric drives" 1/e Wiley Eastern Ltd 1990.
- 4) V. R. Moorthi, "Power Electronics, Devices, Circuits and industrial applications", 2/e Oxford University Press, 2005.

**22UEEE722      Modern Trends in Transmission Systems      (3 - 0 - 0) 3**
**Contact Hrs.: 39**
**Course Learning Objectives (CLOs):**

The students are expected to learn FACTS concept, transmission interconnection, FACTS controllers, shunt, series, combined shunt, and series connected controllers. The students are required to get exposure to power semiconductor devices like MOSFET, MOS turn OFF thyristor, emitter turn OFF thyristor, integrated gate commuted thyristor (IGCT). They are also required to learn Static shunt compensator SVC and STATCOM, general aspects of DC transmission and comparison of it with AC transmission and control of HVDC converters and systems.

**Course Outcomes (COs):**

| Description of the Course Outcome:<br>At the end of the course the student will be able to: |                                                                                       | Mapping to PO's (1 to 12)/ PSO's (1 to 3) |                    |                  |
|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------|--------------------|------------------|
|                                                                                             |                                                                                       | Substantial Level (3)                     | Moderate Level (2) | Slight Level (1) |
| CO-1                                                                                        | Discuss the basic concepts of FACTS.                                                  | 1, 2                                      |                    |                  |
| CO-2                                                                                        | Select power semiconductor devices and converter configuration for FACTS application. | 1, 2                                      |                    |                  |
| CO-3                                                                                        | Analyse performance of shunt FACTS devices.                                           | 1, 2                                      | 3, 5               |                  |
| CO-4                                                                                        | Analyse performance of series FACTS devices.                                          | 1, 2                                      | 3, 5               |                  |
| CO-5                                                                                        | Discuss the configuration and performance of HVDC power transmission.                 | 1, 2                                      | 5                  |                  |

|      |                                                                     |    |  |  |
|------|---------------------------------------------------------------------|----|--|--|
| CO-6 | Carry out a self-study in FACTS and HVDC in the form of Case study. | 12 |  |  |
|------|---------------------------------------------------------------------|----|--|--|

| POs           | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level | 3.0  | 3.0  | 2.0  |      | 2.0  |      |      |      |      |       |       | 3.0   |       |       |       |

**Prerequisites:** 1. Electrical Power Generation, Transmission, Distribution and Utilization. 2. Power System Analysis and Stability 3. Switchgear and Protection 5. Power Electronics

**Contents:**

**Unit-I**

**FACTS: Concepts and general system configuration:** Transmission, interconnection, flow of power in AC system, power flow and dynamic stability consideration, relative importance of controllable parameters, basic types of FACTS controllers, shunt, series, combined shunt, and series connected controllers. Significance of power semiconductor devices in FACTS application.

**08 Hrs.**

**Unit-II**

**Power semiconductor devices and converters for FACTS:** Types of high-power devices, principle of high-power device characteristics and requirements, power device material, diode, MOSFET, MOS turn OFF thyristor, emitter turn OFF thyristor, integrated gate commuted thyristor (GCT&IGCT). Voltage sourced converters: basic concepts, single phase full wave bridge converter operation, square wave voltage harmonics for a single-phase bridge 3 phase full wave bridge converter. Self and line commutated current source converter: basic concepts, 3 phase full wave diode rectifier, thyristor-based converter, current sourced converter with turnoff devices, current sourced versus voltage source converter.

**08 Hrs.**

**Unit-III**

**Static shunt compensator SVC and STATCOM:** Objective of shunt compensation, methods of controllable Var generation, static Var compensator, SVC and STATCOM, comparison between, SVC and STATCOM.

**08 Hrs.**

**Unit-IV**

**Static series compensators:** Objectives of series compensation GCSC, TSSC, TCSC and SSSC, variable impedance type of series compensation, switching converter type series compensation, external control for series reactive compensators.

**08 Hrs.**

**Unit-V**

**HVDC transmission:** Historical sketch, Comparison of HVAC and HVDC Transmission. Earlier practices, Present Trends-Thyristor valves, Self commutated valves, Active filters, Tunable ac filters, ac-dc measurements, DSP controllers, Compact station design. **07 Hrs.**

**Case study:** Students will carry out a self-study in FACTS or HVDC as assignment. **13 Hrs.**

**Reference Books:**

- 1) Narian Hingorani, L Gyugyi," Understanding FACTS: concepts and technology of flexible AC transmission systems" IEEE Press ISBN 0-7803-3455-8
- 2) K. R. Padiyar," HVDC Power Transmission Systems" 2/e, New Academic Science, 2011.
- 3) E.W. Kimbark, "Direct current Transmission"1/e, Wiley-Interscience,1971.
- 4) Prabha Kundur, "Power system stability and control" 9th reprint, TMH, 2007.
- 5) S. Rao, "EHV AC, HVDC Transmission & Distribution Engineering" 3/e, Khanna publishers, 2003.
- 6) HVDC and FACTS Controller- Application of static converters in Power System; Vijay K Sood Kluwer Academic Publishers 2004.

**22UEEE731      AI and its Applications to Power Systems      (3 - 0 - 0) 3**

**Contact Hrs: 39**

**Course Learning Objectives (CLOs):**

The students are expected to learn basic concepts of AI, soft and hard computing. They study about artificial intelligence and relevance of fuzzy logic, fuzzification and defuzzification. Further, they are expected to learn genetic algorithms and apply AI techniques to power system applications.

**Course Outcomes (COs):**

| <b>Description of the Course Outcome:</b><br>At the end of the course the student will be able to: |                                                                                               | <b>Mapping to PO's (1 to12)/ PSO's (1 to 3)</b> |                           |                         |
|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------|-------------------------|
|                                                                                                    |                                                                                               | <b>Substantial Level (3)</b>                    | <b>Moderate Level (2)</b> | <b>Slight Level (1)</b> |
| CO-1                                                                                               | Discuss soft, hard computing techniques, expert systems, fuzzy systems, and genetic algorithm | 1                                               |                           | 2                       |

|      |                                                                                                                  |     |   |   |
|------|------------------------------------------------------------------------------------------------------------------|-----|---|---|
| CO-2 | Illustrate the concepts of feed forward neural networks, learning and understanding of feedback neural networks. | 3   | 1 | 2 |
| CO-3 | Design and develop fuzzy logic for simple systems.                                                               | 3   | 1 | 2 |
| CO-4 | Design and develop genetic algorithms for simple systems.                                                        | 3   | 1 | 2 |
| CO-5 | Assess Fuzzy logic, Expert System and Genetic Algorithm application in power systems operation and control.      | 3,5 |   |   |

| PO's          | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level | 2.0  | 1.33 | 2.33 |      | 3.0  |      |      |      |      |       |       |       |       |       |       |

**Prerequisites:** 1. A course higher level language 2. Mathematics

**Contents:**

#### Unit-I

**Introduction:** Introduction, definition of AI, difference between soft computing techniques and hard computing systems, Expert Systems, brief history of ANN, Fuzzy Logic and Genetic Algorithm. **07 Hrs.**

#### Unit-II

**Artificial neural networks:** Introduction, human brain, model of artificial neuron, neural network architectures, characteristics of neural network, learning methods, architecture of back propagation network, back propagation learning. **08 Hrs.**

#### Unit-III

**Fuzzy logic:** Introduction, Fuzzy versus crisp, fuzzy sets - membership function – basic fuzzy set operations – properties of fuzzy sets, crisp relations- fuzzy Cartesian product, operations on fuzzy relations, fuzzy logic - fuzzy quantifiers- fuzzy inference, fuzzy rule-based system, defuzzification methods. **08 Hrs.**

**Unit-IV**

**Genetic algorithms:** Working principles, difference between genetic algorithm and traditional methods, different types of coding methods, fitness function, reproduction, different types of cross over methods in genetic algorithm, mutation.

**08 Hrs.**

**Unit-V**

**Applications of AI techniques in electrical systems:** Applications of ANN, Fuzzy logic, Expert System and Genetic Algorithm in power systems operation and control.

**08 Hrs.**

**Reference Books:**

- 1) S. Rajasekaran, G. A. V. Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms" PHI, 1/e, New Delhi, 2003.
- 2) Abe Springer, "Neural Networks and Fuzzy Systems Theory and Applications", Science & Business Media, 2012.
- 3) D. E. Goldberg, "Genetic Algorithms" Pearson Education India, 1/e, Dec – 2006.
- 4) Weerakorn Ongsakul, "Artificial Intelligence in Power System Optimization" CRC Press, May-2013

**22UEEE732**

**VLSI Circuits and Designs**

**(3-0-0) 3**

**Contact Hours: 39**

**Course Learning Objectives (CLOs):**

The students are expected to recall the basics of microelectronics. Further to know the electrical properties of different devices at different operating conditions. They are required to learn regarding basic circuit concepts, scaling of MOS circuits and sub system design. They are to learn the VLSI circuit design concepts. They will also to know of special purpose sub systems.

**Course Outcomes (COs):**

| <b>Description of the Course Outcome:</b><br>At the end of the course the student will be able to: |                                                                                                            | <b>Mapping to PO's(1 to 12)/PSO's(1 to 3)</b> |                           |                         |
|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------|-------------------------|
|                                                                                                    |                                                                                                            | <b>Substantial Level (3)</b>                  | <b>Moderate Level (2)</b> | <b>Slight Level (1)</b> |
| CO-1                                                                                               | Review the concepts of MOS and Bi-CMOS fabrication; Demonstrate basic electrical properties of MOS device. | 1                                             |                           |                         |

|      |                                                                                                                                                                 |     |       |  |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------|--|
| CO-2 | Explain different forms of pull-up, Bi-CMOS inverters and latch up in CMOS; Illustrate VLSI design rules for n-MOS and CMOS.                                    | 2   |       |  |
| CO-3 | Apply the concept of sheet resistance and area capacitance to VLSI circuits; comprehend the concept of scaling the device parameters and limitation of scaling. | 2   |       |  |
| CO-4 | Synthesize VLSI circuits using basic components / blocks; Demonstrate VLSI sub system design                                                                    |     | 3     |  |
| CO-5 | Learn clock distribution, concept of $L \frac{di}{dt}$ noise; Understand TG and CPL logic used in VLSI circuits.                                                | 2,5 | PSO-3 |  |

| POs           | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level | 2.2  | 2.0  | 2.33 |      | 3.0  |      |      |      |      |       |       |       |       |       | 2.0   |

**Prerequisites:** 1 Digital Electronics. 2. HDL (preferred)

### Contents:

#### Unit-I

**Review of Microelectronics:** Introduction to MOS technology: Introduction to Integrated circuit technology, Production of E-beam masks

**Basic Electrical properties of MOS:** Drain to source current  $I_d$  versus  $V_{ds}$  relationships, MOS  $g_m$  derivation, pass transistor, n-MOS Inverter, Pull-up to Pull-down ratio of inverter.

**07 Hrs.**

#### Unit-II

**Forms of pull-up and Bi-CMOS inverter:** Resistance pull-up, n-MOS depletion pull-up, n-MOS enhancement pull-up, CMOS pull-up; CMOS inverter, Bipolar and CMOS parameters comparison, Bi-CMOS inverters, latch up in CMOS.

**MOS and Bi-CMOS circuit design processes:** Stick diagrams, n-MOS and CMOS-design rules, Double metal process, CMOS  $\lambda$  based rules, Micron rules, Lay-outs.

**09 Hrs.**

### Unit-III

**Basic circuit concepts:** Sheet resistance concept, Silicide, Area capacitance Delay concept, Inverter delay, rise and fall time derivation of CMOS inverter, cascaded drivers, super buffers, Bi-CMOS drivers, Propagation delays, wiring capacitances, Numericals.

**Scaling of MOS circuits:** Scaling model and scaling factors for device parameters, Limitations of scaling, Limit due to current density. **09 Hrs.**

### Unit-IV

**Subsystem design and layout:** Some architecture issues, Switch logic, Gate logic, other forms of CMOS logic; Structured design: parity generator, bus arbitration logic, Multiplexers, Gray to Binary code conversion; Clocked sequential circuit, Other system consideration. **08 Hrs.**

### Unit-V

**Special purpose subsystems:** Power distribution - On chip clock distribution network, IR drops, Ldi / dt noise, chip bypass capacitance; I/O – Basic I/O pad circuits, CPL, CMOS with TG circuits. **06 Hrs.**

**Self-study: Activity based learning: Realization of Boolean expressions, Multiplexers, Encoders, counters, memory cell one or two bit etc using MOSFETS, transmission gates.**

### Reference Books:

- 1) Pucknell, Eshraghian, "Basic VLSI design"-3/e PHI1985.
- 2) Kang Leblebici, "CMOS Digital integrated circuits" ,4/e, Tata McGraw-Hill publication, 2014
- 3) David Harrison, Neil Weiste, Banerjee, "CMOS VLSI Design" 3/e, Pearson publication, 2011.
- 4) Yuan Taun Tak H Ning, "Fundamentals of Modern VLSI Devices", Cambridge Press, South Asia Edition, 2003.

|                  |                          |                         |
|------------------|--------------------------|-------------------------|
| <b>22UEEO741</b> | <b>Electric Vehicles</b> | <b>(3-0-0) 3</b>        |
|                  |                          | <b>Contact Hrs.: 39</b> |

### Course Learning Objectives: (CLOs)

The students are expected to learn the working of Electric Vehicles and recent trends. To analyse different power converter topology used for electric vehicle application. To develop the electric propulsion unit and its control for application of electric vehicles. To design converters for battery charging and explain transformer less topology.

**Course Outcomes (COs):**

| Description of the Course<br>Outcome: At the end of the course the student will be able to: |                                                                                                                                                | Mapping to PO's (1 to 12)/ PSO's (1 to 3) |                    |                  |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------|------------------|
|                                                                                             |                                                                                                                                                | Substantial Level (3)                     | Moderate Level (2) | Slight Level (1) |
| CO-1                                                                                        | Analyze the vehicle dynamics and propulsion power requirements under different driving and roadway conditions.                                 | 1,2                                       |                    |                  |
| CO-2                                                                                        | Compare various electric and hybrid electric vehicle configurations and evaluate their tractive effort and energy consumption characteristics. | 1,2                                       |                    |                  |
| CO-3                                                                                        | Evaluate and model different energy storage systems and battery charging techniques suitable for electric vehicles.                            | 1,2                                       |                    |                  |
| CO-4                                                                                        | Examine and select appropriate electric propulsion systems and motor drive configurations for electric vehicles.                               | 1,2                                       |                    |                  |
| CO-5                                                                                        | Design and optimize hybrid electric drivetrain components for improved efficiency and performance.                                             | 1,2                                       | 3                  |                  |

| POs           | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level | 3.0  | 3.0  | 2.0  |      |      |      |      |      |      |       |       |       |       |       |       |

**Prerequisites:** Power Electronics

**Contents:****Unit-I**

**Vehicle Mechanics:** Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power, Force-Velocity Characteristics, Maximum Gradability, Velocity and Acceleration, Constant FTR, Level Road, Velocity Profile, Distance Traversed, Tractive Power, Energy Required, Non-constant FTR, General Acceleration, Propulsion System Design.

**07 Hrs.****Unit-II**

**Electric and Hybrid Electric Vehicles:** Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.

**08 Hrs.****Unit-III**

**Energy storage for EV:** Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Supercapacitors. Power Electronic Converter for Battery Charging: Charging methods for battery, Termination methods, charging from grid, charging from Renewable Energy Sources.

**08 Hrs.****Unit-IV**

**Electric Propulsion:** EV consideration, DC motor drives, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration, and control of Drives.

**08 Hrs.****Unit-V**

**Design of Electric and Hybrid Electric Vehicles:** Series Hybrid Electric Drive Train Design: Operating patterns, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of Parallel Hybrid Electric Drive Train Design: design of engine power capacity, design of electric motor drive capacity, transmission design.

**08 Hrs.****Reference Books:**

- 1) Iqbal Husain - Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- 2) M. Ehsani, Y. Gao, S. Gay and Ali Emadi- Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2003.
- 3) Sheldon S. Williamson - Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

- 4) C.C. Chan and K.T. Chau - Modern Electric Vehicle Technology, OXFORD University, 2001.
- 5) Chris Mi, M. Abul Masrur, David Wenzhong Gao - Hybrid Electric Vehicles Principles and Applications with Practical Perspectives, Wiley Publication, 2011.
- 6) NPTEL Course: Fundamentals of Electric vehicles: Technology & Economics, IIT Madras Prof. Ashok Jhunjhunwala Prof. Prabhjot Kaur Prof. Kaushal Kumar Jha Prof. L Kannan. <https://nptel.ac.in/courses/108106170>.

**22UEEO742                      Energy Storage and Management                      3 - 0 - 0) 3**

**Contact Hrs.: 39**

**Course Learning Objectives: (CLOs):**

The emerging energy generation sources, such as solar and wind, generate energy in variable patterns. Hence, energy storage is becoming of major importance to store and supply energy without any interruption. The energy storage can be in mechanical, electrochemical, or chemical forms. The interdisciplinary students are expected to learn the fundamentals of energy storage, classification, energy management techniques, and the role of batteries and supercapacitors in energy storage. Further, they are also expected to know about the modern methods and trends of energy storage.

**Course Outcomes (COs):**

| Description of the Course<br>Outcome: At the end of the course the student will be able to: |                                                                                                                                                             | Mapping to PO's (1 to 12)/ PSO's (1 to 3) |                    |                  |
|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------|------------------|
|                                                                                             |                                                                                                                                                             | Substantial Level (3)                     | Moderate Level (2) | Slight Level (1) |
| CO-1                                                                                        | <b>Analyse</b> the various technologies and key disciplines involved in energy storage, and <b>define</b> key technical concepts related to energy storage. | 1,2                                       |                    |                  |
| CO-2                                                                                        | <b>Classify</b> various energy storage systems, and <b>compare</b> the ratings and properties of different energy storage systems.                          | 1,2                                       |                    |                  |
| CO-3                                                                                        | <b>Explain</b> the structure and functioning of Battery Energy Storage Systems (BESS) and <b>demonstrate</b>                                                | 1,2                                       |                    | 3                |

|      |                                                                                                                                          |     |  |   |
|------|------------------------------------------------------------------------------------------------------------------------------------------|-----|--|---|
|      | an understanding of supercapacitors used for energy storage.                                                                             |     |  |   |
| CO-4 | <b>Describe</b> the key functions of a Battery Management System (BMS) and its importance in energy management.                          | 1,2 |  | 7 |
| CO-5 | <b>Analyze</b> the role of hydrogen in power-to-power storage systems and <b>describe</b> the emerging trends in energy storage systems. | 1,2 |  |   |

| PO's          | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-13 | PSO-14 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|--------|--------|
| Mapping Level | 3    | 3    |      | 1    |      |      | 1    |      |      |       |       |       |        |        |

**Prerequisites:** Basic electrical engineering and fundamentals of MATLAB

**Contents:**

#### Unit-I

**Energy storage systems overview:** - Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storage and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, the Current electric vehicle market.

**Technical definitions:** Capacity, depth of discharge, state of charge, round trip efficiency, losses, and self-discharge. **08 Hrs.**

#### Unit-II

**Classification based on Physical and electrical systems:** Thermal storage systems, electrochemical storage systems, chemical storage systems, electromagnetic storage systems, and electrochemical storage systems.

**Comparative ratings and properties:** System ratings, energy and power density, specific power, Ragone charts, typical efficiencies, lifetime, and costs. **09 Hrs.**

#### Unit-III

**Battery energy storage system (BESS):** Introduction to BESS, system structure, modelling of batteries, generic modeling, R modelling, Thevenin's

modelling, thermal behavior of batteries, thermal modelling, ageing of batteries, limitations of BESS, and methods of overcoming the limitations.

**Energy storage by supercapacitors:** General characteristics of supercapacitors, principles and properties, basic modelling of supercapacitors for energy storage. Charging and discharging process of supercapacitors. Examples of application. **09 Hrs.**

#### **Unit-IV**

**Energy management:** Introduction, main functions of battery management system, BMS topologies, estimation of state of charge and state of health in BMS cell balancing techniques, active dissipative and non-dissipative balancing circuits, challenges in BMS, battery disposal, and recycling. **07 Hrs.**

#### **Unit-V**

**Hydrogen energy:** Introduction, power to power storage system based on hydrogen, conversion from hydrogen to electricity, storage of hydrogen.

**Emerging trends in energy storage systems:** Hybrid energy storage systems, Artificial intelligence-based energy storage systems, Machine learning-based energy storage systems, energy storage policies and standards. **06 hrs.**

#### **Reference Books/resources:**

- 1) Energy storage- System and components , Alfred Rufer., Taylor & Francis Group, 2017
- 2) Emerging Trends in Energy Storage Systems and Industrial Applications. Nayan Kumar, Prabhansu, Academic Press,2022
- 3) Energy Management Systems and SCADA, IIT Madras, Dr. K. Shanti Swarup(Online) <https://nptel.ac.in/courses/108106022>
- 4) Storage Systems, IISc Bangalore, Dr. K. Gopinath(Online) <https://nptel.ac.in/courses/106108058>

**VIII Semester**

**22UEEL800. Technical Seminar / Independent Study (0-0-2) 1**

**Contact Hrs.: 26**

**Course Learning Objectives (CLOs):**

The students are expected to learn how to carry out literature survey to locate the state-of-the-art technology in engineering domain of their interest. They are required to carry out selection of an emerging topic beyond the syllabus relevant to Electrical, Electronics and Computer related areas, study the same in detail, understand the concept, analyze, and present effectively before the target audience. Further, they are expected to know how to write a paper in the required format. They are also required to learn the effective communication and modalities of technical interactions.

**Course Outcomes (COs):**

| <b>Description of the Course Outcome:</b><br>At the end of the course the student will be able to: |                                                                                                                                              | <b>Mapping to PO's (1 to12)/ PSO's (1 to 3)</b> |                           |                                 |
|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------|---------------------------------|
|                                                                                                    |                                                                                                                                              | <b>Substantial Level (3)</b>                    | <b>Moderate Level (2)</b> | <b>Slight Level (1)</b>         |
| CO-1                                                                                               | Select a technical topic in emerging area by referring to renowned journals                                                                  | 12                                              | 2                         | 6, PSO-3                        |
| CO-2                                                                                               | To study and understand the concept given in the paper /literature                                                                           |                                                 | 2                         | 6, 8, PSO-2, PSO-3              |
| CO-3                                                                                               | Compile the information and prepare a write up/report/paper                                                                                  |                                                 |                           | 1, 2, 6, 8, 9, 11, PSO-2, PSO-3 |
| CO-4                                                                                               | Make presentation with effective communication and in all will come to know the state-of-the-art technology in E&E Engg. and allied branches | 10                                              | 5, 9                      | 8, PSO-2, PSO-3                 |

| PO's                 | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|----------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| <b>Mapping Level</b> | 1.0  | 1.6  |      |      | 2.0  | 1.0  |      | 1.0  | 1.5  | 3.0   | 1.0   | 3.0   |       | 1.0   | 1.0   |

**Prerequisites:** Knowledge of both theory and practical courses learnt in all the previous Semesters.

**Contents:**

1. Select a topic from an emerging area relevant to electrical sciences beyond curriculum and understand, analyze, and present it for 15 minutes followed by 5 minutes for questions and answers. Further, they are to submit the seminar material in the form of a paper in IEEE format. All the students are required to attend all the 52 slots.
2. Present the technical innovative/novel work carried out in the laboratory.

**Typical procedure to conduct technical Seminar:**

- All the students are informed to select a topic from the field of their interest from their branch or relevant to their branch and register the topic with the faculty(ies.) In charge of Seminar.
- Two faculty members assigned to carry out this activity. The faculty members prepare the schedule of the seminar spread over the entire semester and display the same in the notice board.
- Change of seminar topic is not allowed once registered, however in the case of genuine reasons only once change of topic may be permitted.
- Based on the number of Hrs. mentioned in the scheme, 4-6 students shall present the seminar in one slot of 2/3 Hrs..
- The faculty members shall conduct the seminar session every week as per the schedule in the slot mentioned on the time table and carry out the evaluation.
- Attendance is compulsory for all the students for all the seminars.
- The students are required to submit two hard copies of report not exceeding 6 pages and one soft copy of seminar report one week prior to their date of presentation.
- Report shall be in IEEE format viz A4 size paper, Title: Bold, Times new Roman Font 14, Sub heading & Body of the text: Times new Roman font 12. Margin for left should be 1 ½.
- Student name, USN, seminar date should be mentioned on the report.
- Presentation is for about 15-20 minutes, followed by 5 minutes for questions and answers.
- Typical evaluation methodology shown in table below: For presentation, the following points not limited to may be considered; Concept, understanding, depth of the knowledge, originality of the topic, Quality of PPT, communication skills etc. For report evaluation, the following points not limited to may be considered Adherence to IEEE format, relevance of topic, subject depth and originality in writing etc.

The seminar is aimed at as an educative program for the students. This is because, the students shall listen to 60- 70 seminars on different topics from emerging areas is as good as undergoing a course on latest happenings in the related branch of Engineering.

| Sl. No. | Parameters for Assessment  | % of weightage for CIE and SEE |
|---------|----------------------------|--------------------------------|
| 1.      | Domain Knowledge and skill | 40                             |
| 2.      | Presentation               | 20                             |
| 3.      | Question and Answer        | 20                             |
| 4.      | Report                     | 20                             |

|                               |                                    |                      |
|-------------------------------|------------------------------------|----------------------|
| <b>22UEEL801</b>              | <b>Major Project-II/Internship</b> | <b>(12 Weeks) 10</b> |
| <b>Contact Hrs.: 12 Weeks</b> |                                    |                      |

**Course Learning Objectives (CLOs):**

The students are expected to learn working in a team and on multidisciplinary projects. They are expected to carry out the intensive literature survey to locate the state-of-the-art technology in his engineering field of interest. They must learn to formulate/define the problem for the project work. They will learn to design, develop, analyze, test, interpret the results, fabricate, simulate, write code etc. relevant to their project work. They are also expected to acquire the skills of summarizing the work into a project report and in all, can carry out the technical work assigned to them independently.

**Course Outcomes (COs):**

| Description of the Course Outcome:<br>At the end of the course the student will be able to: |                                                                                                                          | Mapping to PO's (1 to12)/ PSO's (1 to 3) |                    |                        |
|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------|--------------------|------------------------|
|                                                                                             |                                                                                                                          | Substantial Level (3)                    | Moderate Level (2) | Slight Level (1)       |
| CO-1                                                                                        | Carry out the literature survey to locate the state-of-the-art technology in his Engineering field of interest           | 2                                        |                    | 4, 5, PSO-2, PSO-3     |
| CO-2                                                                                        | Define/formulate the problem for the project work                                                                        | 2,3                                      | 1,4,5              | PSO-2, PSO-3           |
| CO-3                                                                                        | Design, develop, analyze, test, interpret the results, fabricate, simulate, write code etc. relevant to his project work | 3                                        | 5                  | 7,8,9,12, PSO-2, PSO-3 |
| CO-4                                                                                        | Summarize the work into a project report and in all can carry out the technical work assigned                            | 10                                       |                    | 6,8,11, PSO-2, PSO-3   |

| PO's          | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level |      | 3.0  | 3.0  | 1.5  | 1.66 | 1.0  | 1.0  | 1.0  | 1.0  | 2.0   | 1.0   | 1.0   |       | 1.0   | 1.0   |

**Prerequisites:** Knowledge of both theory and practical courses learnt in all the previous Semesters and relevant value-added information.

**Major project-II** is the continuation from **Major project – I** in which the students are expected to go for material collection, survey, visits, data collection, preliminary design, analysis, model development, code writing, field work etc. The same project team formed for phase –I will continue the work under the guidance of the same faculty member. For all the projects, problems may be domain specific or interdisciplinary also in nature. A committee consisting of minimum 3 faculty members of which guide is a member shall evaluate at the end for CIE. There is a viva voce examination which shall be examined by two examiners one internal and one external to the college appointed by COE based on the suggestions by the respective HoD.

**Reference materials/books:**

1. Engineering books.
2. Journals.
3. Manuals and data sheets.
4. Software packages.
5. Previous project reports.
6. Product information brochures.
7. Interaction with academia and industrial experts.
8. Internet etc.

**General Instructions to Students:**

1. Students are expected to Design the problem modules in consultation with project guide/supervisor. Students are expected to submit Design Phase (Design Aspects in Phase-II) approved by project guide, to the project coordinator as per the schedule notified. A copy is to be maintained with students and the guide. Designs will be the base line for the implementation module.
2. Notification/schedules and evaluation procedures will be sent to all students in the Google groups created in the department.

3. Evaluation of Design Phase, implementation of each module Exploring different test cases with respect to each module is done in 8<sup>th</sup> semester.
4. Final Project Report will be prepared includes the content of Phase-I and Phase-II.

| Sl. No. | Parameters for Assessment                                   | % of weightage for CIE and SEE |
|---------|-------------------------------------------------------------|--------------------------------|
| P1      | Project Synopsis/ Proposal Evaluation                       | 15                             |
| P2      | Literature survey/Technology used / Architectural design    | 15                             |
| P3      | Requirement Analysis (SRS)                                  | 15                             |
| P4      | Design methodology/Demonstration of tool used for designing | 10                             |
| P5      | Implementation modules                                      | 15                             |
| P6      | Discussion of test cases /Project demonstration             | 15                             |
| P7      | Project Report (Phase-I and Phase-II)                       | 10                             |
| P8      | Paper Publication / Presentation                            | 05                             |

**22UEEL802****Summer Internship****(4 Weeks) 3****Duration:4 Weeks.**

The students are to undergo internship in Private industries/R&D organizations/Centers of Excellence/Laboratories of Reputed Institutions/Govt. & Semi Govt. organizations, PSUs, construction companies, entrepreneurial organizations, inter departments within the college etc. to get an exposure to the external world for a period of **4 weeks** in the summer vacation after VI sem and before start of VII semester. The students are to prepare a report on the internship work carried out. The internal faculty shall monitor the student and award CIE marks. The student shall present his/her work before a panel of examiners consisting of HoD, Guide and one faculty member during VII semester as final exam. The performance shall be communicated to the CoE office and the same shall reflect in the VII semester grade card.

**Course Outcomes (COs):**

| Description of the Course Outcome:<br>At the end of the course the student will be able to: |                                                                                         | Mapping to PO's (1 to 12)/ PSO's (1 to 3) |                    |                  |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------|--------------------|------------------|
|                                                                                             |                                                                                         | Substantial Level (3)                     | Moderate Level (2) | Slight Level (1) |
| CO-1                                                                                        | Know the industrial environment.                                                        | 1,10                                      | 7, 9,11            | 6,12             |
| CO-2                                                                                        | Acquire knowledge and skill to use in professional career.                              | 1                                         | 2, 4, 5            | 3                |
| CO-3                                                                                        | Acquire the ability of report preparation and presentation skills.                      | 8,10                                      |                    |                  |
| CO-4                                                                                        | Follow the code of practice in Electrical & Electronics Engineering related activities. | 1                                         |                    | 6, 8             |

| PO's          | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 | PSO-1 | PSO-2 | PSO-3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Mapping Level | 3.0  | 2.0  | 1.0  | 2.0  | 2.0  | 1.0  | 2.0  | 2.0  | 2.0  | 3.0   | 2.0   | 1.0   |       |       |       |

**Prerequisites:** Knowledge of both theory and practical courses learnt in all the previous Semesters and relevant value-added information.

**Evaluation and rubrics:** A faculty shall guide and monitor the internship activity of a batch consisting of 4 to 6 students. A committee consisting of two faculty members shall evaluate the internship work considering the parameters such as nature and extent of exposure to the external engineering world, understanding, report preparation, presentation and knowledge gained etc. There is a semester end examination SEE for internship – II. The performance shall be communicated to the CoE office at the end of VIII semester and shall reflect in VIII semester grade card.

| Sl. No. | Parameters for Assessment  | % of weightage for CIE and SEE |
|---------|----------------------------|--------------------------------|
| 1.      | Domain Knowledge and skill | 40                             |
| 2.      | Presentation               | 20                             |
| 3.      | Question and Answer        | 20                             |
| 4.      | Report                     | 20                             |

**CIE and SEE Evaluation (from 2022-23 batch)****Courses with LTP3-0-0 and 4-0-0 or 2-2-0/3-2-0****Continuous Internal Evaluation (CIE):**

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course each of 5 marks. Total CTA marks-10
- $CIE = 40(\text{from tests}) + 10(\text{from CTA}) = 50 \text{ marks}$

**Semester End Examination (SEE):**

- SEE is conducted for 100 marks with 3 Hrs. duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 Hrs. both for 3 and 4 credits courses.
- The Question paper is to be set for 100 marks for 3 and 4 credits courses.