VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examination and Syllabus
B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
III TO VIII SEMESER
(Effective from Academic year 2015-16)
CATEGORIZATION FOR THE THINKING PROCESS

Bloom’s Taxonomy (Revised)

- Can the student create a new product or point of view?
  - assemble, construct, create, design, develop, formulate, write

- Can the student justify a stand or decision?
  - appraise, argue, defend, judge, select, support, value, evaluate

- Can the student distinguish between different parts?
  - appraise, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test

- Can the student use information in a new way?
  - choose, demonstrate, dramatize, employ, illustrate, interpret, operate, schedule, sketch, solve, use, write

- Can the student explain ideas or concepts?
  - classify, describe, discuss, explain, identify, locate, recognize, report, select, translate, paraphrase

- Can the student recall or remember the information?
  - define, duplicate, list, memorize, recall, repeat, state
### Bloom’s Revised Taxonomy
#### Levels, Level Definitions and attributes levels along with action verbs that can be used when developing learning outcomes.

<table>
<thead>
<tr>
<th>Level</th>
<th>Level Definitions and attributes</th>
<th>Verbs (not comprehensive)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower order thinking skills (LOTS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remembering (Knowledge)</strong> $L_1$</td>
<td>Students exhibit memory/rote memorization of previously learnt materials by recognition, recalling facts, terms, basic concepts, and simple answers. Able to remember, but not necessarily fully understanding the material.</td>
<td>Copy, Choose, Define, Discover, Describe, Duplicate, Enumerate, Find, How, Identify, Label, List, Locate, Listen, Memorize, Match, Name, Omit, Quote, Recall, Relate, Reproduce, Recognize, Select, Show, Spell, Tell, Tabulate, Who, When, Where etc.</td>
</tr>
<tr>
<td><strong>Understanding (Comprehension)</strong> $L_2$</td>
<td>Students demonstrate understanding of facts and ideas by interpreting, exemplifying, classifying, inferring, summarizing, comparing and explaining main ideas with own words.</td>
<td>Ask, Classify, Compare, Contrast, Demonstrate, Describe, Extend, Differentiate, Distinguish, Discuss, Express, Explain, Group, Illustrate, Infer, Interpret, Outline, Paraphrase, Rephrase, Relate, Show, Summarize, Select, Translate, Restate etc.</td>
</tr>
<tr>
<td><strong>Applying (Application)</strong> $L_3$</td>
<td>Students solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different way.</td>
<td>Calculate, Predict, Apply, Solve, Illustrate, Use, Demonstrate, Determine, Model, Build, Construct, Develop, Experiment With, Identify, Make Use Of, Organize, Plan, Select etc.</td>
</tr>
<tr>
<td><strong>Higher order thinking skills (HOTS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analysing (Analysis)</strong> $L_4$</td>
<td>Students are able to examine and break information into component parts by identifying motives, causes, arrangement, logic and semantics. They can make inferences and find evidence to support generalization.</td>
<td>Analyse, Assume, Break Down, Classify, Categorize, Conclusion, Compare, Contrast, Diagram, Discover, Dissect, Distinguish, Divide, Examine, Function, Illustrate, Inference, Inspect, List, Motive, Outline, Relationships, Simplify, Survey, Take Part In, Test For etc.</td>
</tr>
<tr>
<td><strong>Evaluating (Evaluation)</strong> $L_5$</td>
<td>Students are able to present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria. They can justify a decision or course of action.</td>
<td>Agree, Appraise, Assess, Award, Build, Create, Compose, Choose, Compare, Conclude, Criteria, Criticize, Design, Derive, Develop, Decide, Deduct, Determine, Disprove, Defend, Estimate, Formulate, Generate, Invent, Modify, Evaluate, Explain, Influence, Judge, Interpret, Justify, Mark, Measure, Perceive, Rate, Prioritize, Recommend, Rule On, Select, Support, Value etc.</td>
</tr>
<tr>
<td><strong>Creating (Synthesis)</strong> $L_6$</td>
<td>Students are able to compile, generate or view information, ideas or products together in a different way by combining elements in a new pattern or by proposing alternative solutions. Also, use information to form a unique product. This requires creativity and originality.</td>
<td>Assemble, Adapt, Anticipate, Build, Change, Choose, Combine, Collaborate, Collect, Create, Compile, Compose, Construct, Delete, Design, Develop, Discuss, Develop, Devise, Elaborate, Estimate, Formulate, Happen, Hypothesize, Imagine, Improve, Invent, Imagine, Intervene, Make Up, Maximize, Modify, Originate, Plan, Predict, Propose, Rearrange, Solve, Suppose, Substitute, Test etc.</td>
</tr>
</tbody>
</table>

**Graduate attributes:** Graduate attributes are the qualities, skills and understandings a university community agrees its students should develop during their time with the institution. These attributes include but go beyond the disciplinary expertise or technical knowledge that has traditionally formed the core of most university courses. They are qualities that also prepare graduates as agents of social good in an unknown future.

Bowden, Hart, King, Trigwell & Watts (2000)
Scheme of Teaching and Examination
### III SEMESTER

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject (Course)</th>
<th>Title</th>
<th>Teaching Dept.</th>
<th>Teaching Hours /Week</th>
<th>Examination</th>
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<tr>
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<td>Theory</td>
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<tr>
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<tr>
<td>2</td>
<td>15EE32</td>
<td>Core Subject</td>
<td>Electric Circuit Analysis</td>
<td>EEE</td>
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<tr>
<td>3</td>
<td>15EE33</td>
<td>Core Subject</td>
<td>Transformers and Generators</td>
<td>EEE</td>
<td>04</td>
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<tr>
<td>4</td>
<td>15EE34</td>
<td>Core Subject</td>
<td>Analog Electronic Circuits</td>
<td>EEE</td>
<td>04</td>
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</tr>
<tr>
<td>5</td>
<td>15EE35</td>
<td>Core Subject</td>
<td>Digital System Design</td>
<td>EEE</td>
<td>04</td>
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</tr>
<tr>
<td>6</td>
<td>15EE36</td>
<td>Foundation Course</td>
<td>Electrical and Electronic Measurements</td>
<td>EEE</td>
<td>04</td>
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<tr>
<td>7</td>
<td>15EEL37</td>
<td>Laboratory</td>
<td>Electrical Machines Laboratory -1</td>
<td>EEE</td>
<td>01-Hour Instruction</td>
<td>02-Hour Practical</td>
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<tr>
<td>8</td>
<td>15EEL38</td>
<td>Laboratory</td>
<td>Electronics Laboratory</td>
<td>EEE</td>
<td>01-Hour Instruction</td>
<td>02-Hour Practical</td>
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</tbody>
</table>

**TOTAL**

- **Theory:** 24 hours
- **Practical:** 6 hours

**Credits:**

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Foundation Course:** The courses based upon the content that leads to Knowledge enhancement.
### IV SEMESTER

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject (Course)</th>
<th>Title</th>
<th>Teaching Dept.</th>
<th>Teaching Hours /Week</th>
<th>Examination</th>
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<tbody>
<tr>
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<td>Theory</td>
<td>Practical/ Drawing</td>
</tr>
<tr>
<td>1</td>
<td>15MAT41</td>
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<td>Engineering Mathematics-IV</td>
<td>Maths</td>
<td>04</td>
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<tr>
<td>2</td>
<td>15EE42</td>
<td>Core Subject</td>
<td>Power Generation and Economics</td>
<td>EEE</td>
<td>04</td>
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</tr>
<tr>
<td>3</td>
<td>15EE43</td>
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<td>Transmission and Distribution</td>
<td>EEE</td>
<td>04</td>
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<tr>
<td>4</td>
<td>15EE44</td>
<td>Core Subject</td>
<td>Electric Motors</td>
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<td>5</td>
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<tr>
<td>6</td>
<td>15EE46</td>
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<td>Operational Amplifiers and Linear ICs</td>
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<td>02-Hour Practical</td>
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<td>Op-amp and Linear ICs Laboratory</td>
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<td>02-Hour Practical</td>
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<td></td>
<td>Theory: 24 hours</td>
<td>Practical: 06 hours</td>
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</table>

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. **Foundation Course:** The courses based upon the content that leads to Knowledge enhancement.
### V Semester

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject (Course)</th>
<th>Title</th>
<th>Teaching Department</th>
<th>Teaching Hours /Week</th>
<th>Examination</th>
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<td>Theory/Practical</td>
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<tr>
<td>1</td>
<td>15EE51</td>
<td>Core Subject</td>
<td>Management and Entrepreneurship</td>
<td>EEE</td>
<td>04 --</td>
<td>03 80 20</td>
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<tr>
<td>2</td>
<td>15EE52</td>
<td>Core Subject</td>
<td>Microcontroller</td>
<td>EEE</td>
<td>04 --</td>
<td>03 80 20</td>
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<tr>
<td>3</td>
<td>15EE53</td>
<td>Core Subject</td>
<td>Power Electronics</td>
<td>EEE</td>
<td>04 --</td>
<td>03 80 20</td>
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<tr>
<td>4</td>
<td>15EE54</td>
<td>Core Subject</td>
<td>Signals and Systems</td>
<td>EEE</td>
<td>04 --</td>
<td>03 80 20</td>
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<td>15EE55X</td>
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<td>EEE</td>
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<td>03 --</td>
<td>03 80 20</td>
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<td>Microcontroller Laboratory</td>
<td>EEE</td>
<td>01-Hour Instruction</td>
<td>03 80 20</td>
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<td>8</td>
<td>15EEL58</td>
<td>Laboratory</td>
<td>Power Electronics Laboratory</td>
<td>EEE</td>
<td>01-Hour Instruction</td>
<td>03 80 20</td>
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</tbody>
</table>

**TOTAL**

- **Theory:** 22 hours
- **Practical:** 6 hours

**Elective**

<table>
<thead>
<tr>
<th>Professional Elective</th>
<th>Open Elective **** Offered by the Department of Electrical and Electronics Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courses under Code 15EE55X</td>
<td>Title</td>
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<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>15EE551</td>
<td>Introduction to Nuclear Power</td>
</tr>
<tr>
<td>15EE552</td>
<td>Electrical Engineering Materials</td>
</tr>
<tr>
<td>15EE553</td>
<td>Estimating and Costing</td>
</tr>
<tr>
<td>15EE554</td>
<td>Special Electrical Machines</td>
</tr>
</tbody>
</table>

**Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided:**

- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Electives relevant to chosen specialization/ branch.
3. **Open Elective:** Electives from other technical and/or emerging subject areas.
VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI  
SCHEME OF TEACHING AND EXAMINATION - 2015-16  
B.E. ELECTRICAL AND ELECTRONICS ENGINEERING  
CHOICE BASED CREDIT SYSTEM (CBCS)

**VI SEMESTER**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject (Course)</th>
<th>Title</th>
<th>Teaching Department</th>
<th>Teaching Hours /Week</th>
<th>Examination Credits</th>
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<tbody>
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<td>Theory</td>
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<tr>
<td>2</td>
<td>15EE62</td>
<td>Core Subject</td>
<td>Power System Analysis – I</td>
<td>EEE</td>
<td>04</td>
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<td>3</td>
<td>15EE63</td>
<td>Core Subject</td>
<td>Digital Signal Processing</td>
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<tr>
<td>4</td>
<td>15EE64</td>
<td>Core Subject</td>
<td>Electrical Machine Design</td>
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<tr>
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<tr>
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<td>Open Elective - II</td>
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<td>Control System Laboratory</td>
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<td>02-Hour Practical</td>
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<tr>
<td>8</td>
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<td>Laboratory</td>
<td>Digital Signal Processing Laboratory</td>
<td>EEE</td>
<td>01-Hour Instruction</td>
<td>02-Hour Practical</td>
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</tbody>
</table>

**Elective**

<table>
<thead>
<tr>
<th>Courses under Code 15EE65X</th>
<th>Title</th>
<th>Courses under Code 15EE66Y</th>
<th>Title</th>
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<tbody>
<tr>
<td>15EE651</td>
<td>Computer Aided Electrical Drawing</td>
<td>15EE661</td>
<td>Artificial Neural Networks and Fuzzy logic</td>
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<tr>
<td>15EE652</td>
<td>Advanced Power Electronics</td>
<td>15EE662</td>
<td>Sensors and Transducers</td>
</tr>
<tr>
<td>15EE653</td>
<td>Energy Audit and Demand side Management</td>
<td>15EE663</td>
<td>Batteries and Fuel Cells for Commercial, Military and Space Applications</td>
</tr>
<tr>
<td>15EE654</td>
<td>Solar and Wind Energy</td>
<td>15EE664</td>
<td>Industrial Servo Control Systems</td>
</tr>
</tbody>
</table>

**Elective**

Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided:
- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

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2. **Professional Elective**: Electives relevant to chosen specialization/ branch.
3. **Open Elective**: Electives from other technical and/ or emerging subject areas.
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Subject (Course)</th>
<th>Title</th>
<th>Teaching Department</th>
<th>Teaching Hours/Week</th>
<th>Examination</th>
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<td>15EE72</td>
<td>Core Subject</td>
<td>Power System Protection</td>
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<td>04</td>
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</tr>
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<td>3</td>
<td>15EE73</td>
<td>Core Subject</td>
<td>High Voltage Engineering</td>
<td>EEE</td>
<td>04</td>
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<td>4</td>
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<td>Professional Elective – III</td>
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<td>15EEL77</td>
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<td>EEE</td>
<td>01-Hour Instruction</td>
<td>02-Hour Practical</td>
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**TOTAL**

Elective

<table>
<thead>
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<th>Title</th>
<th>Courses under Code 15EE75Y</th>
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<tbody>
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<td>15EE741</td>
<td>Advanced Control Systems</td>
<td>15EE751</td>
<td>FACTs and HVDC Transmission</td>
</tr>
<tr>
<td>15EE742</td>
<td>Utilization of Electrical Power</td>
<td>15EE752</td>
<td>Testing and Commissioning of Power System Apparatus</td>
</tr>
<tr>
<td>15EE743</td>
<td>Carbon Capture and Storage</td>
<td>15EE753</td>
<td>Spacecraft Power Technologies</td>
</tr>
<tr>
<td>15EE744</td>
<td>Power System Planning</td>
<td>15EE754</td>
<td>Industrial Heating</td>
</tr>
</tbody>
</table>

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. **Professional Elective:** Elective relevant to chosen specialization/branch.

3. **Project Phase – I + Seminar:** Literature Survey, Problem Identification, objectives and Methodology. Submission of synopsis and seminar.

4. **Internship / Professional Practice:** To be carried between the VI and VII semester vacation or VII and VIII semester vacation period.
## VIII SEMESTER

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Subject (Course)</th>
<th>Title</th>
<th>Teaching Department</th>
<th>Teaching Hours /Week</th>
<th>Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Theory</td>
<td>Practical/</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Drawing</td>
</tr>
<tr>
<td>1</td>
<td>15EE81</td>
<td>Core Subject</td>
<td>Power System Operation and Control</td>
<td>EEE</td>
<td>04</td>
<td>--</td>
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<tr>
<td>2</td>
<td>15EE82</td>
<td>Core Subject</td>
<td>Industrial Drives and Applications</td>
<td>EEE</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>15EE83X</td>
<td>Professional Elective</td>
<td>Professional Elective – V</td>
<td>EEE</td>
<td>03</td>
<td>--</td>
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<tr>
<td>4</td>
<td>15EE84</td>
<td>Core Subject</td>
<td>Internship / Professional Practice</td>
<td>EEE</td>
<td></td>
<td></td>
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<td>5</td>
<td>15EEP85</td>
<td>Core Subject</td>
<td>Project Work Phase -II</td>
<td>EEE</td>
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<td>06</td>
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<td>6</td>
<td>15EES86</td>
<td>Core Subject</td>
<td>Seminar</td>
<td>EEE</td>
<td>--</td>
<td>04</td>
</tr>
</tbody>
</table>

**TOTAL**

- **Theory:** 11 hours
- **Practical:** 10 hours
- **Total:** 15
- **Credits:** 31
  - 39
  - 700
  - 20

### Professional Elective – V

**Courses under Code 15EE83X**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE831</td>
<td>Smart Grid</td>
</tr>
<tr>
<td>15EE832</td>
<td>Operation and Maintenance of Solar Electric Systems</td>
</tr>
<tr>
<td>15EE833</td>
<td>Integration of Distributed Generation</td>
</tr>
<tr>
<td>15EE834</td>
<td>Power System in Emergencies</td>
</tr>
</tbody>
</table>

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. **Professional Elective:** Elective relevant to chosen specialization/ branch.

3. **Internship / Professional Practice:** To be carried between the VI and VII semester vacation or VII and VIII semester vacation period.
III SEMESTER DETAILED SYLLABUS
**B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - III**

**ENGINEERING MATHEMATICS –III (Core Course)**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Hours</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15MAT31</td>
<td>20</td>
<td>04</td>
<td>03</td>
<td>50</td>
<td>80</td>
<td>04</td>
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</tbody>
</table>

**Course objectives:**
- The objectives of this course is to introduce students to the mostly used analytical and numerical methods in the different engineering fields by making them to learn Fourier series, Fourier transforms and Z-transforms, statistical methods, numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variations.

### Module-1

**Fourier Series:** Periodic functions, Dirichlet’s condition, Fourier Series of periodic functions with period $2\pi$ and with arbitrary period $2c$. Fourier series of even and odd functions. Half range Fourier Series, practical harmonic analysis-Illustrative examples from engineering field.

**Teaching Hours:** 10

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-2

**Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transform.

**Z-transform:** Difference equations, basic definition, $z$-transform-definition. Standard $z$-transforms. Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems. Inverse $z$-transform. Applications of $z$-transforms to solve difference equations.

**Teaching Hours:** 10

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-3

**Statistical Methods:** Review of measures of central tendency and dispersion. Correlation-Karl Pearson’s coefficient of correlation-problems. Regression analysis- lines of regression (without proof) – problems Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form $y = ax + b, y = ax^2 + bx + c$ and $y = ae^{bx}$.


**Teaching Hours:** 10

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₃ – Applying.</th>
</tr>
</thead>
</table>

### Module-4

**Finite differences:** Forward and backward differences, Newton’s forward and backward interpolation formulae. Divided differences- Newton’s divided difference formula. Lagrange’s interpolation formula and inverse interpolation formula (all formulae without proof)-Problems.

**Numerical integration:** Simpson’s $(1/3)^{th}$ and $(3/8)^{th}$ rules, Weddle’s rule (without proof) – Problems.

**Teaching Hours:** 10

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₃ – Applying.</th>
</tr>
</thead>
</table>

### Module-5

**Vector integration:** Line integrals-definition and problems, surface and volume integrals-definition, Green’s theorem in a plane, Stokes and Gauss-divergence theorem(without proof) and problems.

**Calculus of Variations:** Variation of function and Functional, variational problems. Euler’s equation, Geodesics, hanging chain, problems.

**Teaching Hours:** 10

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L₂ – Understanding, L₄ – Analysing.</td>
</tr>
</tbody>
</table>
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III

15MAT31 ENGINEERING MATHEMATICS –III (Core Subject) (continued)

Course outcomes:
At the end of the course the student will be able to:

- Know the use of periodic signals and Fourier series to analyze circuits and system communications.
- Explain the general linear system theory for continuous-time signals and digital signal processing using the Fourier Transform and z-transform.
- Employ appropriate numerical methods to solve algebraic and transcendental equations.
- Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applications in the field of electro-magnetic and gravitational fields and fluid flow problems.
- Determine the extremals of functional and solve the simple problems of the calculus of variations.

Graduate Attributes (As per NBA)

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books

1. Higher Engineering Mathematics
   B.S. Grewal
   Khanna Publishers

2. Advanced Engineering Mathematics
   E. Kreyszig
   John Wiley & Sons

Reference books

3. A Text Book of Engineering Mathematics
   N.P. Bali and Manish Goyal
   Laxmi Publishers
   7th Edition, 2010

4. Higher Engineering Mathematics
   B.V. Ramana
   Tata McGraw-Hill
   2006

5. Higher Engineering Mathematics
   H. K. Dass Er.
   Rajnish Verma
   S. Chand

Web links and Video Lectures:
# Module 1: Basic Concepts


### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Level</th>
</tr>
</thead>
</table>

### Module 2: Network Theorems

Analysis of networks, with and without dependent ac and dc sources by Thevenin’s and Norton’s theorems. Analysis of ac and dc circuits for maximum power transfer to resistive and complex loads. Application of Millman’s theorem and Super Position theorem to multisource networks. Reciprocity theorem and its application.

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Level</th>
</tr>
</thead>
</table>

### Module 3: Transient Analysis

Review of ordinary linear non homogeneous first and second order differential equations with constant coefficients. Transient analysis of ac and dc circuits by classical method. Transient analysis of dc and ac circuits. Behaviour of circuit elements under switching action \((t = 0)\) and \((t = \infty)\). Evaluation of initial conditions.

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Level</th>
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</thead>
</table>

### Module 4: Laplace Transformation


### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Level</th>
</tr>
</thead>
</table>

### Module 5: Unbalanced Three phase systems

Analysis of three phase systems, calculation of real and reactive powers.

Two Port networks: Definition, Open circuit impedance, Short circuit admittance and Transmission parameters and their evaluation for simple circuits. Network functions of one port and two port.
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - III  

15EE32 ELECTRIC CIRCUIT ANALYSIS (Core Course) (continued)

<table>
<thead>
<tr>
<th>Module-5 (continued)</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two Port networks (continued): networks, properties of poles and zeros of network functions.</td>
<td></td>
</tr>
<tr>
<td>Complex Wave analysis: Analysis of simple circuits with non-sinusoidal excitation.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td></td>
</tr>
</tbody>
</table>

Course outcomes:
At the end of the course the student will be able to:

- Apply knowledge of mathematics, science, and engineering to the analysis and design of electrical circuits.
- Identify, formulate, and solve engineering problems in the area circuits and systems.
- Analyze the solution and infer the authenticity of it.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem analysis.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text/Reference Books

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Matthew N O Sadiku</td>
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<tr>
<td></td>
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<td>James A Svoboda</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Wilhelm C Miller</td>
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</table>
**B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)\n**
**CHOICE BASED CREDIT SYSTEM (CBCS)**
**SEMESTER - III**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Total Number of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE33</td>
<td>20</td>
<td>50</td>
</tr>
</tbody>
</table>

**Course objectives:**
- To understand the concepts of transformers and their analysis.
- To suggest a suitable three phase transformer connection for a particular operation.
- To understand the concepts of generator and to evaluate their performance.
- To explain the requirement for the parallel operation of transformers and synchronous generators.

<table>
<thead>
<tr>
<th>Module-1</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single phase Transformers:</strong> Review of Principle of operation, constructional details of shell type and core type single-phase transformers, EMF equation, losses and commercial efficiency, conditions for maximum efficiency (No question shall be set from the review portion). Salient features of ideal transformer, operation of practical transformer under no load and on load with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of equivalent circuit parameters and predetermination of efficiency-commercial and all-day. Voltage regulation and its significance.</td>
<td>10</td>
</tr>
<tr>
<td><strong>Three-phase Transformers:</strong> Introduction, Constructional features of three-phase transformers. Choice between single unit three-phase transformer and a bank of three single-phase transformers. Transformer connection for three phase operation – star/star, delta/delta, star/delta, zigzag/star and V/V, choice of connection. Phase conversion - Scott connection for three-phase to two-phase conversion. Labelling of three-phase transformer terminals, vector groups. Equivalent circuit of three phase transformers.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>[L_4 – ] Remembering, [L_3 – ] Understanding, [L_2 – ] Applying, [L_1 – ] Analysing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-2</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parallel Operation of Transformers:</strong> Necessity of Parallel operation, conditions for parallel operation – Single phase and three phase. Load sharing in case of similar and dissimilar transformers. \n<strong>Autotransformers and Tap changing transformers:</strong> Introduction to auto transformer - copper economy, equivalent circuit, three phase auto connection and voltage regulation. Voltage regulation by tap changing – off circuit and on load. \n<strong>Tertiary winding Transformers:</strong> Necessity of tertiary winding, equivalent circuit and voltage regulation, tertiary winding in star/star transformers, rating of tertiary winding.</td>
<td>10</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>[L_2 – ] Understanding, [L_3 – ] Applying, [L_4 – ] Analysing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-3</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transformers (continuation):</strong> Cause and effects of harmonics, Current inrush in transformers, noise in transformers. Objects of testing transformers, polarity test, Sumpner’s test. \n<strong>Direct current Generator</strong> – Review of construction, types, armature windings, relation between no load and terminal voltage (No question shall be set from the review portion). Armature reaction, Commutation and associated problems, no load and full load characteristics. Reasons for reduced dependency on dc generators. \n<strong>Synchronous generators:</strong> Review of construction and operation of salient &amp; non-salient pole synchronous generators (No question shall be set from the review portion). Armature windings, winding factors, emf equation. Harmonics – causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit.</td>
<td>10</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>[L_2 – ] Understanding, [L_3 – ] Applying, [L_4 – ] Analysing, [L_5 – ] Evaluating.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-4</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synchronous generators (continuation):</strong> Generator load characteristic. Voltage regulation, excitation control for constant terminal voltage. Generator input and output. Parallel operation of</td>
<td>10</td>
</tr>
</tbody>
</table>
## Module-4 (continued)

<table>
<thead>
<tr>
<th>Synchronous generators (continuation):</th>
<th>Teaching Hours</th>
</tr>
</thead>
</table>

| Synchronous generators (continuation): |  |
| Effects of saliency, two-reaction theory, Direct and Quadrature reactance, power angle diagram, reluctance power, slip test. |  |

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Module-5

| Synchronous generators (continuation): |  |
| Open circuit and short circuit characteristics, Assessment of reactance- short circuit ratio, synchronous reactance, adjusted synchronous reactance and Potier reactance. Voltage regulation by EMF, MMF, ZPF and ASA methods. |  |

| Performance of synchronous generators: |  |
| Capability curve for large turbo generators and salient pole generators. Starting, synchronizing and control, Hunting and dampers. |  |

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Course outcomes:

At the end of the course the student will be able to:

- Explain the construction and operation and performance of transformers.
- Explain different connections for the three phase operations, their advantages and applications.
- Explain the construction and operation of Synchronous machines and evaluate the regulation of synchronous machines by different methods.
- Analyze the operation of the synchronous machine connected to infinite machine.

### Graduate Attributes (As per NBA)

- Engineering Knowledge
- Problem analysis

### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text/Reference Books

<table>
<thead>
<tr>
<th>#</th>
<th>Book Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
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</table>
## B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
**CHOICE BASED CREDIT SYSTEM (CBCS)**  
**SEMESTER - III**

### ANALOG ELECTRONIC CIRCUITS (Core Course)

<table>
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<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Hours</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE34</td>
<td>20</td>
<td>04</td>
<td>03</td>
<td>50</td>
<td>80</td>
</tr>
</tbody>
</table>

**Credits - 04**

**Course objectives:**
- Provide the knowledge for the analysis of diode and transistor circuits.
- Develop skills to design the electronic circuits like amplifiers and oscillators.
- Highlight the importance of FET and MOSFET.

### Module-1

**Diode Circuits:** Review of diodes as rectifiers (No question shall be set from review portion). Diode clamping and clamping circuits.

**Transistor biasing and stabilization:** Operating point, analysis and design of fixed bias circuit, self-bias circuit, Emitter stabilized bias circuit, voltage divider bias circuit, stability factor of different biasing circuits. Problems.

**Transistor switching circuits:** Transistor switching circuits, PNP transistors, thermal compensation techniques.

**Revised Bloom’s Taxonomy Level**
- L₁ – Remembering
- L₂ – Understanding
- L₃ – Applying

### Module-2

**Transistor at low frequencies:** BJT transistor modelling, CE fixed bias configuration, voltage divider bias, emitter follower, CB configuration, collector feedback configuration, analysis using h – parameter model, relation between h – parameters model of CE, CC and CB modes, Millers theorem and its dual.

**Transistor frequency response:** General frequency considerations, low frequency response, Miller effect capacitance, high frequency response, multistage frequency effects.

**Revised Bloom’s Taxonomy Level**
- L₂ – Understanding
- L₃ – Applying
- L₄ – Analysing
- L₅ – Evaluating

### Module-3

**Multistage amplifiers:** Cascade and cascode connections, Darlington circuits, analysis and design.

**Feedback amplifiers:** Feedback concept, different types, practical feedback circuits, analysis and design of feedback circuits.

**Revised Bloom’s Taxonomy Level**
- L₁ – Remembering
- L₂ – Understanding
- L₃ – Applying
- L₄ – Analysing

### Module-4

**Power amplifiers:** Amplifier types, analysis and design of different power amplifiers, distortion in power amplifiers.

**Oscillators:** Principle of operation, analysis and derivation of frequency of oscillation of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator and frequency stability.

**Revised Bloom’s Taxonomy Level**
- L₁ – Remembering
- L₂ – Understanding
- L₃ – Applying
- L₄ – Analysing

### Module-5

**FETs:** Construction, working and characteristics of JFET and MOSFET. Biasing of JFET and MOSFET, JFET and MOSFET amplifiers, analysis and design.

**Revised Bloom’s Taxonomy Level**
- L₁ – Remembering
- L₂ – Understanding
- L₃ – Applying
- L₄ – Analysing
Course outcomes:
At the end of the course the student will be able to:
- Utilize the characteristics of transistor for different applications.
- Design and analyze biasing circuits for transistor.
- Design, analyze and test transistor circuitry as amplifiers and oscillators.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Modern tool usage, Ethics.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text/Reference Books

|---|--------------------------------------|-----------------------------------|---------|-------------------|
### Course objectives:
- To impart the knowledge of combinational circuit design.
- To impart the knowledge of Sequential circuit design.
- To provide the basic knowledge about VHDL & its use.

#### Module-1
**Principles of combinational logic:** Definition of combinational, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 and 5 variables. Incompletely specified functions (Don’t care terms). Simplifying max - term equations. Quine-McClusky minimization technique, Quine - McClusky using don’t care terms, Reduced Prime Implicant tables, Map entered variables.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>

#### Module-2
**Analysis and design of Combinational Logic:** General approach, Decoders-BCD decoders, Encoders. Digital multiplexers-using multiplexers as Boolean function generators. Adders and Subtractors-Cascading full adders, Look ahead carry, Binary comparators. Design methods of building blocks of combinational logics.

<table>
<thead>
<tr>
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</table>

#### Module-3

<table>
<thead>
<tr>
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</tr>
</thead>
</table>

#### Module-4
**Sequential Design:** Introduction, Mealy and Moore models, State machine notation, synchronous sequential circuit analysis and design. Construction of state Diagrams, Counters Design.

|--------------------------------|---------------------------------------------------------------------|

#### Module-5
**HDL:** Introduction, A brief history of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, Simulation and synthesis, Brief comparison of VHDL and Verilog.

**Data-Flow Descriptions:** Highlights of Data flow descriptions, Structure of data-flow description, Data type-vectors.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>
Course outcomes:

At the end of the course the student will be able to:

- Design and analyze combinational & sequential circuits
- Design circuits like adder, sub tractor, code converter etc.
- Understand counters and sequence generators.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Modern tool usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text/Reference Books

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Digital Logic Applications and Design</td>
<td>John M Yarbrough</td>
<td>Cengage Learning</td>
<td></td>
<td>2011</td>
</tr>
<tr>
<td>7</td>
<td>Digital Circuits and Design</td>
<td>D.P. Kothari J. S. Dhillon</td>
<td>Pearson</td>
<td>First Print 2015</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Circuit Design and Simulation with VHDL</td>
<td>Volnei A Pedroni</td>
<td>PHI</td>
<td>2nd Edition,</td>
<td></td>
</tr>
</tbody>
</table>
### Subject: Electrical and Electronic Measurements (Foundation Course)

**Subject Code:** 15EE36  
**IA Marks:** 20  
**Number of Lecture Hours/Week:** 04  
**Exam Hours:** 03  
**Total Number of Lecture Hours:** 50  
**Exam Marks:** 80  
**Credits:** 04

**Course Objectives:**
- To understand the concept of units and dimensions.
- To measure resistance, inductance, capacitance by use of different bridges.
- To study the construction and working of various meters used for measurement.
- To have the working knowledge of electronic instruments and display devices.

<table>
<thead>
<tr>
<th>Module</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module-1</strong></td>
<td>10</td>
</tr>
<tr>
<td><strong>Units and Dimensions:</strong> Review of fundamental and derived units. SI units (No question shall be set from the review portion). Dimensional equations, problems.</td>
<td></td>
</tr>
<tr>
<td><strong>Measurement of Resistance:</strong> Wheatstone’s bridge, sensitivity, limitations. Kelvin’s double bridge. Earth resistance measurement by fall of potential method and by using Megger.</td>
<td></td>
</tr>
<tr>
<td><strong>Measurement of Inductance and Capacitance:</strong> Sources and detectors, Maxwell’s inductance bridge, Maxwell’s inductance and capacitance bridge, Hay’s bridge, Anderson’s bridge, Desauty’s bridge, Schering bridge. Shielding of bridges. Problems.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</td>
</tr>
</tbody>
</table>

| Module-2 | 10 |
| **Measurement of Power, Energy, Power factor and Frequency:** Review of Dynamometer wattmeter construction and operation (No question shall be set from the review portion). Torque expression, Errors and minimization, UPF and LPF wattmeters. Measurement of real and reactive power in 3 phase circuits. Review of Induction type energy meter construction and operation (No question shall be set from the review portions). Errors, adjustments and calibration of single and three phase energy meters, Problems. Construction and operation of single-phase and three phase dynamometer type power factor meter. Weston frequency meter and phase sequence indicator. | |
| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

| Module-3 | 10 |
| **Extension of Instrument Ranges:** Desirable features of ammeters and voltmeters. Shunts and multipliers. Construction and theory of instrument transformers. Desirable characteristics, Errors of CT and PT. Turns compensation, Illustrative examples, Silsbee’s method of testing CT. | |
| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

| Module-4 | 10 |
| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |
### Module-5

**Display Devices:** Introduction, character formats, segment displays, Dot matrix displays, Bar graph displays. Cathode ray tubes, Light emitting diodes, Liquid crystal displays, Nixes, Incandescent, Fluorescent, Liquid vapour and Visual displays. Display multiplexing and zero suppression.

**Recording Devices:** Introduction, Strip chart recorders, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and xy recorders. Magnetic tape recorders, Direct recording, Frequency modulation recording, Pulse duration modulation recording, Digital tape recording, Ultraviolet recorders. Biomedical recorders, Electro Cardio Graph (ECG), Electroencephalograph, Electromyograph. Noise in reproduction.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Course outcomes:

At the end of the course the student will be able to:

- Explain the importance of units and dimensions.
- Measure resistance, inductance and capacitance by different methods.
- Explain the working of various meters used for measurement of power and energy.
- Explain the working of different electronic instruments and display devices.

### Graduate Attributes (As per NBA)

**Engineering Knowledge**

### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text/Reference Books

<table>
<thead>
<tr>
<th>No.</th>
<th>Title of the Book</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Electrical Measuring Instruments and Measurements</td>
<td>S.C. Bhargava</td>
<td>BS Publications</td>
<td>2013</td>
</tr>
<tr>
<td>6</td>
<td>Electronic Instrumentation and Measurements</td>
<td>David A Bell</td>
<td>Oxford University</td>
<td>3rd Edition, 2013</td>
</tr>
</tbody>
</table>
Course objectives:
- Conducting of different tests on transformers and synchronous machines and evaluation of their performance.
- Verify the parallel operation of two single phase transformers.
- Study the connection of single phase transformers for three phase operation and phase conversion.
- Study of synchronous generator connected to infinite bus.

<table>
<thead>
<tr>
<th>Sl. NO</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open Circuit and Short circuit tests on single phase step up or step down transformer and predetermination of (i) Efficiency and regulation (ii) Calculation of parameters of equivalent circuit.</td>
</tr>
<tr>
<td>2</td>
<td>Sumpner’s test on similar transformers and determination of combined and individual transformer efficiency.</td>
</tr>
<tr>
<td>3</td>
<td>Parallel operation of two dissimilar single-phase transformers of different kVA and determination of load sharing and analytical verification given the Short circuit test data.</td>
</tr>
<tr>
<td>4</td>
<td>Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency and regulation under balanced resistive load.</td>
</tr>
<tr>
<td>5</td>
<td>Comparison of performance of 3 single-phase transformers in delta – delta and V – V (open delta) connection under load.</td>
</tr>
<tr>
<td>6</td>
<td>Scott connection with balanced and unbalanced loads.</td>
</tr>
<tr>
<td>7</td>
<td>Separation of hysteresis and eddy current losses in single phase transformer.</td>
</tr>
<tr>
<td>8</td>
<td>Voltage regulation of an alternator by EMF and MMF methods.</td>
</tr>
<tr>
<td>9</td>
<td>Voltage regulation of an alternator by ZPF method.</td>
</tr>
<tr>
<td>10</td>
<td>Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.</td>
</tr>
<tr>
<td>11</td>
<td>Performance of synchronous generator connected to infinite bus, under constant power and variable excitation &amp; vice versa.</td>
</tr>
<tr>
<td>12</td>
<td>Power angle curve of synchronous generator.</td>
</tr>
</tbody>
</table>

Revised Bloom’s Taxonomy Level | L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating

Course outcomes:
At the end of the course the student will be able to:
- Conduct different tests on transformers and synchronous generators and evaluate their performance.
- Connect and operate two single phase transformers of different KVA rating in parallel.
- Connect single phase transformers for three phase operation and phase conversion.
- Assess the performance of synchronous generator connected to infinite bus.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
# B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
## CHOICE BASED CREDIT SYSTEM (CBCS)
### SEMESTER - III

**ELECTRONICS LABORATORY**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Hours</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EEL38</td>
<td></td>
<td>03</td>
<td>03</td>
</tr>
<tr>
<td>Number of Practical Hours/Week</td>
<td>03</td>
<td>42</td>
<td>80</td>
</tr>
</tbody>
</table>

**Credits - 02**

### Course Objectives:
- To design and test half wave and full wave rectifier circuits.
- To design and test different amplifier and oscillator circuits using BJT.
- To study the simplification of Boolean expressions using logic gates.
- To realize different Adders and Subtractors circuits.
- To design and test counters and sequence generators.

### Experiments

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design and Testing of Full wave – centre tapped transformer type and Bridge type rectifier circuits with and without Capacitor filter. Determination of ripple factor, regulation and efficiency.</td>
</tr>
<tr>
<td>2</td>
<td>Static Transistor characteristics for CE, CB and CC modes and determination of h parameters.</td>
</tr>
<tr>
<td>3</td>
<td>Frequency response of single stage BJT and FET RC coupled amplifier and determination of half power points, bandwidth, input and output impedances.</td>
</tr>
<tr>
<td>4</td>
<td>Design and testing of BJT - RC phase shift oscillator for given frequency of oscillation.</td>
</tr>
<tr>
<td>5</td>
<td>Determination of gain, input and output impedance of BJT Darlington emitter follower with and without bootstrapping.</td>
</tr>
<tr>
<td>6</td>
<td>Simplification, realization of Boolean expressions using logic gates/Universal gates.</td>
</tr>
<tr>
<td>7</td>
<td>Realization of half/Full adder and Half/Full Subtractors using logic gates.</td>
</tr>
<tr>
<td>8</td>
<td>Realization of parallel adder/Subtractors using 7483 chip- BCD to Excess-3 code conversion and Vice Versa.</td>
</tr>
<tr>
<td>9</td>
<td>Realization of Binary to Gray code conversion and vice versa.</td>
</tr>
<tr>
<td>10</td>
<td>Design and testing Ring counter/Johnson counter.</td>
</tr>
<tr>
<td>11</td>
<td>Design and testing of Sequence generator.</td>
</tr>
<tr>
<td>12</td>
<td>Realization of 3 bit counters as a sequential circuit and MOD – N counter design using 7476, 7490, 74192, 74193.</td>
</tr>
</tbody>
</table>

### Revised Bloom’s Taxonomy Level
- L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating

### Course Outcomes:
At the end of the course the student will be able to:
- Design and test different diode circuits.
- Design and test amplifier and oscillator circuits and analyse their performance.
- Use universal gates and ICs for code conversion and arithmetic operations.
- Design and verify on of different counters.

### Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**** END ****
IV SEMESTER DETAILED SYLLABUS
Course Objectives:
The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.

Module-1

**Numerical Methods:** Numerical solution of ordinary differential equations of first order and first degree, Taylor’s series method, modified Euler’s method, Runge-Kutta method of fourth order, Milne’s and Adams-Bashforth predictor and corrector methods (No derivations of formulae).

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>

Revised Bloom’s Taxonomy Level

Module-2

**Numerical Methods:** Numerical solution of second order ordinary differential equations, Runge-Kutta method and Milne’s method.

**Special Functions:** Series solution-Frobenious method. Series solution of Bessel’s differential equation leading to J₀(x)-Bessel’s function of first kind. Basic properties, recurrence relations and orthogonality. Series solution of Legendre’s differential equation leading to Pₙ(x)-Legendre polynomials. Rodrigue’s formula, problems.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>

Module-3

**Complex Variables:** Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions-Cauchy-Riemann equations in cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy’s theorem and Cauchy’s integral formula, Residue, poles, Cauchy’s Residue theorem (without proof) and problems.

**Transformations:** Conformal transformations, discussion of transformations:
\[ w = z^2, w = e^z, w = x + \frac{1}{z} (z \neq 0) \] and bilinear transformations-problems.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₂ – Understanding, L₃ – ApplyingL₄ – Analysing.</th>
</tr>
</thead>
</table>

Module-4

**Probability Distributions:** Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.

**Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₃ – Applying.</th>
</tr>
</thead>
</table>

Module-5

**Sampling Theory:** Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student’s t-distribution, Chi-square distribution as a test of goodness of fit.

**Stochastic process:** Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₃ – ApplyingL₄ – Analysing.</th>
</tr>
</thead>
</table>
Course outcomes:
- Use appropriate single step and multi-step numerical methods to solve first and second order ordinary differential equations arising in flow data design problems.
- Explain the idea of analyticity, potential fields residues and poles of complex potentials in field theory and electromagnetic theory.
- Employ Bessel's functions and Legendre's polynomials for tackling problems arising in continuum mechanics, hydrodynamics and heat conduction.
- Describe random variables and probability distributions using rigorous statistical methods to analyze problems associated with optimization of digital circuits, information, coding theory and stability analysis of systems.
- Apply the knowledge of joint probability distributions and Markov chains in attempting engineering problems for feasible random events.

Graduate Attributes (As per NBA)

Question paper pattern:
- The question paper will have ten full questions carrying equal marks.
- Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books:
1. Higher Engineering Mathematics
   - B.S. Grewal
   - Khanna Publishers
2. Advanced Engineering Mathematics
   - E. Kreyszig
   - John Wiley & Sons

Reference books:
3. A Text Book of Engineering Mathematics
   - N.P.Bali and Manish Goyal
   - Laxmi Publishers
   - 7th Edition, 2010
4. Higher Engineering Mathematics
   - B.V.Ramana
   - McGraw-Hill
   - 2006
5. Higher Engineering Mathematics
   - H. K. Dass and Er. RajnishVerma
   - S.Chand publishing

Web links and Video Lectures
# Course Objectives:

- Explain the arrangement and operation of hydroelectric, steam, diesel, gas turbine and nuclear power plants and working of major equipment in the plants.
- Classification of substation and explain the operation of different substation equipment.
- Explain the importance of grounding and different grounding methods used in practice.
- Explain the economics of power generation and importance of power factor.

## Module-1

**Hydroelectric Power Plants:** Hydrology, run off and stream flow, hydrograph, flow duration curve, Mass curve, reservoir capacity, dam storage. Hydrological cycle, merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, elements of the plant, Classification of the plants based on water flow regulation, water head and type of load the plant has to supply. Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines Governing of turbines, selection of water turbines. Underground, small hydro and pumped storage plants. Choice of size and number of units, plant layout and auxiliaries.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

## Module-2

**Steam Power Plants:** Introduction, Efficiency of steam plants, Merits and demerits of plants, selection of site. Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling, Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control, Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, plant auxiliaries.

**Diesel Power Plant:** Introduction, Merits and demerits, selection site, elements of diesel power plant, applications.

**Gas Turbine Power Plant:** Introduction, Merits and demerits, selection site, Fuels for gas turbines, Elements of simple gas turbine power plant, Methods of improving thermal efficiency of a simple steam power plant, Closed cycle gas turbine power plants. Comparison of gas power plant with steam and diesel power plants.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

## Module-3

**Nuclear Power Plants:** Introduction, Economics of nuclear plants, Merits and demerits, selection of site, Nuclear reaction, Nuclear fission process, Nuclear chain reaction, Nuclear energy, Nuclear fuels. Nuclear plant and layout, Nuclear reactor and its control, Classification of reactors, power reactors in use, Effects of nuclear plants, Disposal of nuclear waste and effluent, shielding.

<table>
<thead>
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<th>L₁ – Remembering, L₂ – Understanding.</th>
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</table>

## Module-4

**Substations:** Introduction to Substation equipment; Transformers, High Voltage Fuses, High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters, High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors, Measuring Instruments, and power line carrier communication equipment. Classification of substations – indoor and outdoor, Selection of site for substation, Busbar arrangement schemes and single line diagrams of substations.
## Module-4 (continued)

<table>
<thead>
<tr>
<th>Substations (continued)</th>
<th>Interconnection of power stations. Introduction to gas insulated substation, Advantages and economics of Gas insulated substation.</th>
</tr>
</thead>
</table>

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Teaching Hours</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Module-5

**Economics:** Introduction, Effect of variable load on power system, classification of costs, Cost analysis. Interest and Depreciation, Methods of determination of depreciation, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants. Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, disadvantages, causes, methods of improving power factor. Advantages of improved power factor, economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment.

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Teaching Hours</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Course Outcomes:

At the end of the course the student will be able to:

- Describe the working of hydroelectric, steam, nuclear power plants and state functions of major equipment of the power plants.
- Classify various substations and explain the importance of grounding.
- Understand the economic aspects of power system operation and its effects.
- Explain the importance of power factor improvement.

### Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Engineers and Society, Environment and Sustainability.

### Question Paper Pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text/Reference Books

<table>
<thead>
<tr>
<th>#</th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Course in Power Systems</td>
<td>J.B. Gupta</td>
<td>Katson</td>
<td>2008</td>
</tr>
</tbody>
</table>
## course details

**Subject Code**: 15EE43  
**IA Marks**: 20  
**Number of Lecture Hours/Week**: 04  
**Exam Hours**: 03  
**Total Number of Lecture Hours**: 50  
**Exam Marks**: 80  
**Credits**: 04

### Course Objectives:
- To understand the concepts of various methods of generation of power.
- To understand the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
- To design insulators for a given voltage level.
- To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
- To study underground cables for power transmission and evaluate different types of distribution systems.

### Module-1

**Introduction to power system**: Structure of electric power system: generation, transmission and distribution. Advantages of higher voltage transmission: HVAC, EHVAC, UHVAC and HVDC. Interconnection. Feeders, distributors and service mains.

**Overhead transmission lines**: A brief introduction to types of supporting structures and line conductors- Conventional conductors; Aluminium Conductor steel reinforced (ACSR), All – aluminium alloy conductor (AAAC) and All – aluminium conductor (AAC), High temperature conductors; Thermal resistant aluminium alloy (ATI), Super thermal resistant aluminium alloy (ZTAI), Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR), Gap type super thermal resistant aluminium alloy conductor steel reinforced (GZTACSR). Bundle conductor and its advantages. Importance of sag, Sag calculation – supports at same and different levels, effect of wind and ice. Line vibration and vibration dampers. Overhead line protection against lightening; ground wires.

**Overhead line Insulators**: A brief introduction to types of insulators, material used- porcelain, toughened glass and polymer (composite). Potential distribution over a string of suspension insulators. String efficiency, Methods of increasing string efficiency. Arcing horns.

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Module-2

**Line parameters**: Introduction to line parameters- resistance, inductance and capacitance. Calculation of inductance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Inductance of composite – conductors, geometric mean radius (GMR) and geometric mean distance (GMD). Calculation of capacitance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of composite – conductor, geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines.

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>

### Module-3

**Performance of transmission lines**: Classification of lines – short, medium and long. Current and voltage relations, line regulation and Ferranti effect in short length lines, medium length lines considering Nominal T and nominal π circuits, and long lines considering hyperbolic form equations. Equivalent circuit of a long line. ABCD constants in all cases.

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
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<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-4

**Corona**: Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona.

### Revised Bloom’s Taxonomy Level

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>
### Module-4 (continued)


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-5

**Distribution:** Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system. Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution. AC distributors with concentrated and uniform loads. Effect of disconnection of neutral in a 3 phase four wire system.

**Reliability and Quality of Distribution system:** Introduction, definition of reliability, failure, probability concepts, limitation of distribution systems, power quality, Reliability aids.

<table>
<thead>
<tr>
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</tr>
</thead>
</table>

### Course Outcomes:

At the end of the course the student will be able to:

- Explain the concepts of various methods of generation of power.
- Explain the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
- Design and analyze overhead transmission system for a given voltage level.
- Calculate the parameters of the transmission line for different configurations and assess the performance of line.
- Explain the use of underground cables and evaluate different types of distribution systems.

### Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design / development of solutions, Engineers and society, Ethics.

### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text/Reference Books:

1. A Course in Electrical Power | Soni Gupta and Bhatnagar | Dhanpat Rai |
5. Electrical Power | S.L. Uppal | Khanna Publication |
7. Electrical power systems | Ashfaq Hussain | CBS Publication |
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

ELECTRIC MOTORS (Core Subject)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE44</td>
<td>To study the constructional features of Motors and select a suitable drive for specific application.</td>
</tr>
<tr>
<td></td>
<td>To study the constructional features of Three Phase and Single phase induction Motors.</td>
</tr>
<tr>
<td></td>
<td>To study different test to be conducted for the assessment of the performance characteristics of motors.</td>
</tr>
<tr>
<td></td>
<td>To study the speed control of motor by a different methods.</td>
</tr>
<tr>
<td></td>
<td>Explain the construction and operation of Synchronous motor and special motors.</td>
</tr>
</tbody>
</table>

### Module-1
DC Motors: Classification, Back emf, Torque equation, and significance of back emf. Characteristics of shunt, series & compound motors. Speed control of shunt, series and compound motors. Application of motors. DC motor starters – 3 point and 4 point.

Losses and efficiency- Losses in DC motors, power flow diagram, efficiency, condition for maximum efficiency.

Revised Bloom’s Taxonomy Level

### Module-2
Testing of dc motors: Direct & indirect methods of testing of DC motors-Brake test, Swinburne’s test, Retardation test, Hopkinson’s test, Field’s test, merits and demerits of tests.

Three phase Induction motors: Review of concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring (No question shall be set from the review portion). Slip, Torque equation, torque-slip characteristic covering motoring, generating and braking regions of operation. Maximum torque, significance of slip.

Revised Bloom’s Taxonomy Level

### Module-3

Revised Bloom’s Taxonomy Level

### Module-4
Starting and speed Control of Three-phase Induction Motors: Need for starter. Direct on line, Star-Delta and autotransformer starting. Rotor resistance starting. Speed control by voltage, frequency, and rotor resistance methods.


Revised Bloom’s Taxonomy Level

### Module-5

---

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE44</td>
<td>10</td>
</tr>
<tr>
<td>Number of Lecture Hours/Week</td>
<td>04 Exam Hours</td>
</tr>
<tr>
<td>Total Number of Lecture Hours</td>
<td>50 Exam Marks</td>
</tr>
<tr>
<td>Credits</td>
<td>04</td>
</tr>
</tbody>
</table>
### Module-5 (continued)

**Other motors:** Construction and operation of Universal motor, AC servomotor, Linear induction motor and stepper motors.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Course Outcomes:

At the end of the course the student will be able to:

- Explain the constructional features of Motors and select a suitable drive for specific application.
- Analyze and assess the performance characteristics of DC motors by conducting suitable tests and control the speed by suitable method.
- Explain the constructional features of Three Phase and Single phase induction Motors and assess their performance.
- Control the speed of induction motor by a suitable method.
- Explain the operation of Synchronous motor and special motors.

### Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems.

### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text/Reference Books:

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Electric Machines</td>
<td>M.V. Deshpande</td>
<td>PHI Learning</td>
<td>2013</td>
</tr>
</tbody>
</table>
Course Objectives:

- To study different coordinate systems for understanding the concept of gradient, divergence and curl of a vector.
- To study the application of Coulomb’s Law and Gauss Law for electric fields produced by different charge configurations.
- To evaluate the energy and potential due to a system of charges.
- To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
- To study the magnetic fields and magnetic materials.
- To study the time varying fields and propagation of waves in different media.

Module-1


**Electrostatics:** Coulomb’s law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications. Maxwell’s first equation (Electrostatics). Divergence theorem. Problems.

**Revised Bloom’s Taxonomy Level**

|-------|------------------------------------------------------|

Module-2

**Energy and Potential:** Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient. The dipole. Energy density in the electrostatic field. Problems.

**Conductor and Dielectrics:** Current and current density. Continuity of current. Metallic conductors, conductor’s properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Capacitance of two wire line. Problems.

**Revised Bloom’s Taxonomy Level**

|-------|------------------------------------------------------|

Module-3

**Poisson’s and Laplace equations:** Derivations and problems, Uniqueness theorem.


**Revised Bloom’s Taxonomy Level**

|-------|------------------------------------------------------|

Module-4


**Revised Bloom’s Taxonomy Level**

15EE45 ELECTROMAGNETIC FIELD THEORY (Core Subject) (continued)

Module-5

Teaching Hours

**Time varying fields and Maxwell’s equations:** Faraday’s law, Displacement current. Maxwell’s equations in point form and integral form. Problems.

**Uniform plane wave:** Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Problems.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

**Course Outcomes:**

At the end of the course the student will be able to:

- Use different coordinate systems to explain the concept of gradient, divergence and curl of a vector.
- Use Coulomb’s Law and Gauss Law for the evaluation of electric fields produced by different charge configurations.
- Calculate the energy and potential due to a system of charges.
- Explain the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
- Explain the behavior of magnetic fields and magnetic materials.
- Assess time varying fields and propagation of waves in different media.

**Graduate Attributes (As per NBA)**

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text/Reference Books:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Electromagnetism -Theory (Volume -1) -Applications (Volume-2)</td>
<td>Ashutosh Pramanik</td>
<td>PHI Learning</td>
<td>2014</td>
</tr>
<tr>
<td>5</td>
<td>Electromagnetic Field Theory Fundamentals</td>
<td>Bhag Guru et al</td>
<td>Cambridge</td>
<td>2005</td>
</tr>
</tbody>
</table>
### Course Objectives:
- To understand the basics of Linear ICs such as Op-amp, Regulator, Timer & PLL.
- To learn the designing of various circuits using linear ICs.
- To use these linear ICs for specific applications.
- To understand the concept and various types of converters.
- To use these ICs, in Hardware projects.

#### Module-1
**Operational amplifiers:** Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve, open loop configuration, differential amplifier, inverting & non–inverting amplifier, Op-amp with negative feedback; voltage series feedback amplifier-gain, input resistance, output resistance, voltage shunt feedback amplifier-gain, input resistance, output resistance.

**General Linear Applications:** D.C. & A.C amplifiers, peaking amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, differential configuration, instrumentation amplifier.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

#### Module-2
**Active Filters:** First & Second order high pass & low pass Butterworth filters, higher order filters Band pass filters, Band reject filters & all pass filters.
**DC Voltage Regulators:** voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

#### Module-3
**Signal generators:** Triangular / rectangular wave generator, phase shift oscillator, Wien bridge oscillator, oscillator amplitude stabilization, signal generator output controls.
**Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

#### Module-4
**Signal processing circuits:** Precision half wave & full wave rectifiers limiting circuits, clamping circuits, peak detectors, sample & hold circuits.
**A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC, dual slope ADC, digital ramp ADC.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

#### Module-5
**Phase Locked Loop (PLL):** Basic PLL, components, performance factors, applications of PLL IC 565.
**Timer:** Internal architecture of 555 timer, Mono stable, Astable multivibrators and applications.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

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B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) 
CHOICE BASED CREDIT SYSTEM (CBCS)
Course Outcomes:
At the end of the course the student will be able to:
- Explain the basics of linear ICs.
- Design circuits using linear ICs.
- Demonstrate the application of Linear ICs.
- Use ICs in the electronic projects.

Graduate Attributes (As per NBA)
Engineering Knowledge, Design / development of solutions, Conduct investigations of complex Problems.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text/Reference Books:

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Operational Amplifiers and Linear ICs</td>
<td>David A. Bell</td>
<td>Oxford</td>
<td>3rd Edition 2011</td>
</tr>
<tr>
<td>3</td>
<td>Linear Integrated Circuits; Analysis, Design and Applications</td>
<td>B. Somanthan Nair</td>
<td>Wiley India</td>
<td>2013</td>
</tr>
<tr>
<td>7</td>
<td>Op-Amps and Linear Integrated Circuits, Concept and Application</td>
<td>James M Fiore</td>
<td>Cengage</td>
<td>2009</td>
</tr>
</tbody>
</table>
## Subject: Electrical Machines Laboratory - 2

**Subject Code:** 15EEEL47  
**IA Marks:** 20

<table>
<thead>
<tr>
<th>Number of Practical Hours/Week</th>
<th>Exam Hours</th>
<th>IA Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>03</td>
<td>80</td>
</tr>
</tbody>
</table>

### Credits - 02

#### Course Objectives:
- To perform tests on dc machines to determine their characteristics.
- To control the speed of dc motor.
- To conduct test for pre-determination of the performance characteristics of dc machines.
- To conduct load test on single phase and three phase induction motor.
- To conduct test on induction motor to determine the performance characteristics.
- To conduct test on synchronous motor to draw the performance curves.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics.</td>
</tr>
<tr>
<td>2</td>
<td>Field Test on dc series machines.</td>
</tr>
<tr>
<td>3</td>
<td>Speed control of dc shunt motor by armature and field control.</td>
</tr>
<tr>
<td>4</td>
<td>Swinburne's Test on dc motor.</td>
</tr>
<tr>
<td>5</td>
<td>Retardation test on dc shunt motor.</td>
</tr>
<tr>
<td>6</td>
<td>Regenerative test on dc shunt machines.</td>
</tr>
<tr>
<td>7</td>
<td>Load test on three phase induction motor.</td>
</tr>
<tr>
<td>8</td>
<td>No - load and Blocked rotor test on three phase induction motor to draw (i) equivalent circuit and (ii) circle diagram. Determination of performance parameters at different load conditions from (i) and (ii).</td>
</tr>
<tr>
<td>9</td>
<td>Load test on induction generator.</td>
</tr>
<tr>
<td>10</td>
<td>Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.</td>
</tr>
<tr>
<td>11</td>
<td>Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.</td>
</tr>
<tr>
<td>12</td>
<td>Conduct an experiment to draw V and Ω curves of synchronous motor at no load and load conditions.</td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**: L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating

### Course Outcomes:
At the end of the course the student will be able to:
- Test dc machines to determine their characteristics.
- Control the speed of dc motor.
- Pre-determine the performance characteristics of dc machines by conducting suitable tests.
- Perform load test on single phase and three phase induction motor to assess its performance.
- Conduct test on induction motor to pre-determine the performance characteristics.
- Conduct test on synchronous motor to draw the performance curves.

### Graduate Attributes (As per NBA)
Engineering Knowledge, Individual and Team work, Communication.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
**B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)**
**CHOICE BASED CREDIT SYSTEM (CBCS)**
**SEMESTER - IV**

**OP- AMP AND LINEAR IC'S LABORATORY**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>15EEL48</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Practical Hours/Week</td>
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<tr>
<td>Total Number of Practical Hours</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IA Marks</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam Marks</td>
<td>80</td>
</tr>
</tbody>
</table>

**Credits - 02**

**Course Objectives:**
- To conduct different experiments using OP-Amps
- To conduct experiments using Linear IC’s

**a)** Study of pin details, specifications, application features of IC741 (LM741) and IC555 (Timer) through corresponding datasheets (Datasheets are instruction manuals for electronic components. They explain exactly what a component does and how to use it.).

**b)** Comparison of output performance quantity of an Operational Amplifier obtained by rigging up the circuit with the ideal value of:
   - (i) A Non – Inverting Amplifier \( V_{out} = AV_{in} \)
   - (ii) An Inverting Amplifier \( V_{out} = -AV_{in} \)
   - (iii) A Difference Amplifier \( V_{out} = -A(V_p - V_n) \)
   - (iv) A Difference Amplifier with floating inputs \( V_{out} = AV_{in} \)
   - (v) A Non – Inverting Amplifier with negative feedback
   - (vi) An Inverting Amplifier with negative feedback
   - (vii) A Differential Amplifier with a negative feedback
   - (viii) A Differential Amplifier with equalised amplifications.

**c)** Plot of input and output transfer characteristics to analyse and conclude that op-amps are rarely used in open-loop.

**d)** Testing of op – amp.

**Experiments**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design and verify a precision full wave rectifier. Determine the performance parameters.</td>
</tr>
<tr>
<td>2</td>
<td>Design and realize to analyse the frequency response of an op – amp amplifier under inverting and non - inverting configuration for a given gain.</td>
</tr>
<tr>
<td>3</td>
<td>Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.</td>
</tr>
<tr>
<td>4</td>
<td>Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).</td>
</tr>
<tr>
<td>5</td>
<td>Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.</td>
</tr>
<tr>
<td>6</td>
<td>Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.</td>
</tr>
<tr>
<td>7</td>
<td>Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.</td>
</tr>
<tr>
<td>8</td>
<td>Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.</td>
</tr>
<tr>
<td>9</td>
<td>Design and realization of R-2R ladder DAC.</td>
</tr>
<tr>
<td>10</td>
<td>Realization of Two bit Flash ADC</td>
</tr>
<tr>
<td>11</td>
<td>Design and verify an IC 555 timer based pulse generator for the specified pulse.</td>
</tr>
<tr>
<td>12</td>
<td>Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series.</td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**

| L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating |

**Course Outcomes:**

At the end of the course the student will be able to:
- To conduct experiment to determine the characteristic parameters of OP-Amp
- To design test the OP-Amp as Amplifier, adder, subtractor, differentiator and integrator
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
#### CHOICE BASED CREDIT SYSTEM (CBCS)
#### SEMESTER - IV

#### 15EEL48 OP-AMP AND LINEAR ICS LABORATORY (continued)

<table>
<thead>
<tr>
<th>Course Outcomes (continued):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• To design test the OP-Amp as oscillators and filters</td>
</tr>
<tr>
<td>• Design and study of Linear IC’s as multivibrator power supplies.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Graduate Attributes (As per NBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Knowledge, Individual and Team work, Communication.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conduct of Practical Examination:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All laboratory experiments are to be included for practical examination.</td>
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<tr>
<td>2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.</td>
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<tr>
<td>3. Students can pick one experiment from the questions lot prepared by the examiners.</td>
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<tr>
<td>4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.</td>
</tr>
</tbody>
</table>

***** END *****
V SEMESTER DETAILED SYLLABUS
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) 
**CHOICE BASED CREDIT SYSTEM (CBCS)**

**SEMESTER – V**

**MANAGEMENT AND ENTREPRENEURSHIP** (Core Course)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Hours</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE51</td>
<td></td>
<td>04</td>
<td>03</td>
<td>50</td>
<td>80</td>
<td>04</td>
</tr>
</tbody>
</table>

**Course objectives:**
- To introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- To discuss the ways in which work is allocation, structure of organizations, modes of communication and importance of managerial control in business.
- To explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- To explain the role and importance of the entrepreneur in economic development and the concepts of entrepreneurship.
- To explain various types of entrepreneurs and their functions, the myths of entrepreneurship and the factors required for capacity building for entrepreneurs.
- To discuss the importance of Small Scale Industries and the related terms and problems involved.
- To discuss methods for generating new business ideas and business opportunities in India and the important of business plan.
- To introduce the concepts of project management and discuss capital building process.
- To explain project feasibility study and project appraisal and discuss project financing.
- To discuss about different institutions at state and central levels supporting business enterprises.

### Module-1

**Management:** Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art & Profession.

**Revised Bloom’s Taxonomy Level**

### Module-2


**Revised Bloom’s Taxonomy Level**
- L2 – Understanding, L3 – Applying, L4 – Analysing.

### Module-3

**Social Responsibilities of Business:** Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance.
**Entrepreneurship:** Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.

**Revised Bloom’s Taxonomy Level**
- L3 – Applying.
## Module-4


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3 – Applying.</td>
<td>10</td>
</tr>
</tbody>
</table>

### Course outcomes:

At the end of the course the student will be able to:

- Explain the field of management, task of the manager, planning and the need of proper staff, recruitment and selection process.
- Discuss work allocation, the structure of organization, the modes of communication and importance of managerial control in business.
- To explain need of coordination between the manager and staff in exercising the authority and delegating duties.
- To explain the social responsibility of business and leadership
- Explain the concepts of entrepreneurship and the role and importance of the entrepreneur in economic development.
- Show an understanding of the role and importance of Small Scale Industries, business plan and its presentation.
- Discuss the concepts of project management, capitol building process, project feasibility study, project appraisal and project financing.
- Discuss the state/central level institutions/agencies supporting business enterprises.

### Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

## Module-5


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3 – Applying, L4 – Analysing.</td>
<td>10</td>
</tr>
</tbody>
</table>

### Course outcomes:

At the end of the course the student will be able to:

- Explain the concepts of Small Scale Industries, business plan and its presentation.
- Discuss the concepts of project management, capitol building process, project feasibility study, project appraisal and project financing.
- Discuss the state/central level institutions/agencies supporting business enterprises.

### Graduate Attributes (As per NBA)

## Textbooks

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
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</table>

## Reference Books

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Year</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Dynamics of Entrepreneurial Development and Management</td>
<td>Vasant Desai</td>
<td>Himalaya Publishing House</td>
<td>2007</td>
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</tbody>
</table>
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER – V  

MICROCONTROLLER (Core Course)  

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
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<tbody>
<tr>
<td>15EE52</td>
<td>20</td>
<td>50</td>
<td>80</td>
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</table>

Course objectives:  
- To explain the internal organization and working of Computers, microcontrollers and embedded processors.  
- Compare and contrast the various members of the 8051 family.  
- To explain the registers of the 8051 microcontroller, manipulation of data using registers and MOV instructions.  
- To explain different addressing modes of 8051, arithmetic, logic instructions, and programs.  
- To explain develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic, arithmetic operations and data conversion.

Module-1  
**8051 Microcontroller Basics:** Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM.8051 Addressing Modes.  

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

Module-2  
**Assembly programming and instruction of 8051:** Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming.  

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

Module-3  
**8051 programming in C:** Data types and time delay in 8051C, IO programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Accessing code ROM space in 8051C, Data serialization using 8051C.  
**8051 Timer programming in Assembly and C:** Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C.  


Module-4  
**8051 serial port programming in assembly and C:** Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C.  
**8051 Interrupt programming in assembly and C:** 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C.  

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.
### Module-5

**Teaching Hours**: 10

<table>
<thead>
<tr>
<th><strong>Interfacing</strong></th>
<th><strong>Teaching Hours</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>LCD interfacing, Keyboard interfacing.</td>
<td></td>
</tr>
<tr>
<td>ADC, DAC and sensor interfacing: ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning.</td>
<td></td>
</tr>
<tr>
<td><strong>Motor control</strong>: Relay, PWM, DC and stepper motor: Relays and opt isolators, stepper motor interfacing, DC motor interfacing and PWM.</td>
<td></td>
</tr>
<tr>
<td><strong>8051 interfacing with 8255</strong>: Programming the 8255, 8255 interfacing, C programming for 8255.</td>
<td></td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**


### Course outcomes:
At the end of the course the student will be able to:

- Discuss the history of the 8051 and features of other 8051 family members and the internal architecture of the 8051.
- Explains the use of an 8051 assembler, the stack and the flag register, loop, jump, and call instructions.
- Discuss 8051 addressing modes, accessing data and I/O port programming, arithmetic, logic instructions, and programs.
- Develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic and arithmetic operations, data conversion and data serialization.
- Discuss the hardware connection of the 8051 chip, its timers, serial data communication and its interfacing of 8051to the RS232.
- Discuss in detail 8051 interrupts and writing interrupt handler programs.
- Interface 8051 with real-world devices such as LCDs and keyboards, ADC, DAC chips and sensors.
- Interface 8031/51 with external memories, 8255 chip to add ports and relays, opt isolators and motors.

### Graduate Attributes (As per NBA)
Engineering Knowledge, Problem analysis.

### Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

### Textbook


### Reference Books

**Course objectives:**
- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.
- To explain power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and imitations.
- To explain different types of Thyristors, their gate characteristics and gate control requirements.
- To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC-DC, DC-AC converters and Voltage controllers.

**Module-1**

<table>
<thead>
<tr>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction: Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches.</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
</tr>
</tbody>
</table>

**Module-2**

<table>
<thead>
<tr>
<th>Teaching Hours</th>
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<tbody>
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</table>

**Module-3**

<table>
<thead>
<tr>
<th>Teaching Hours</th>
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<tbody>
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</tr>
</tbody>
</table>

**Module-4**

<table>
<thead>
<tr>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled Rectifiers: Introduction, Single-Phase Full Converters, Single-Phase Dual Converters, Three-Phase Full Converters, Three-Phase Dual Converters,</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
</tr>
</tbody>
</table>
Module-5

<table>
<thead>
<tr>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

**DC-DC Converters:** Introduction, principle of step down and step up chopper with RL load, performance parameters, DC-DC converter classification.

**DC-AC converters:** Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters.

---

**Course outcomes:**

At the end of the course the student will be able to:

- Explain application area of power electronics, types of power electronic circuits and switches their characteristics and specifications.
- Explain types of power diodes, their characteristics, and the effects of power diodes on RL circuits.
- Explain the techniques for design, operation and analysis of single phase diode rectifier circuits.
- Explain steady state, switching characteristics and gate control requirements of different power transistors and their limitations.
- Discuss different types of Thyristors, their operation, gate characteristics and gate control requirements.
- Explain designing, analysis techniques and characteristics of thyristor controlled rectifiers.
- Discuss the principle of operation of single phase and three phase DC - DC, DC –AC converters and AC voltage controllers.

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**Graduate Attributes (As per NBA)**

Engineering Knowledge, Problem analysis.

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**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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**Textbook**

1. **Power Electronics: Circuits Devices and Applications**
   - Mohammad H Rashid,
   - Pearson

---

**Reference Books**

1. **Power Electronics: Converters, Applications and Design**
   - Ned Mohan et al
   - Wiley

2. **Power Electronics**
   - Daniel W Hart
   - McGraw Hill

3. **Elements of Power Electronics**
   - Philip T Krein
   - Oxford
Subject Code: 15EE54
IA Marks: 20
Number of Lecture Hours/Week: 04
Exam Hours: 03
Total Number of Lecture Hours: 50
Exam Marks: 80
Credits – 04

Course objectives:
- To discuss arising of signals in different systems.
- To classify the signals and define certain elementary signals.
- To explain basic operations on signals and properties of systems.
- To explain the use of convolution integral and convolution summation in analyzing the response of linear time invariant systems in continuous and discrete time domains.
- To explain the properties of linear time invariant systems in terms of impulse response description.
- To explain determination of response of a given linear time invariant system and to provide a block diagram representation to it.
- To explain Fourier transform representation of continuous time and discrete time non-periodic signals and the properties of Fourier Transforms.
- To explain the applications of Fourier transform representation to study signals and linear time invariant systems.
- To explain the use of Z-transform in the complex exponential representation of discrete time signals and the analysis of systems.

Module-1

Introduction: Definitions of signals and a system, classification of signals, basic operations on signals. Elementary signals viewed as interconnections of operations, properties of systems.  ■

Revised Bloom’s Taxonomy Level:
- L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing,
- L5 – Evaluating.

Module-2


Revised Bloom’s Taxonomy Level:
- L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing,
- L5 – Evaluating.

Module-3


Revised Bloom’s Taxonomy Level:
- L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing,
- L5 – Evaluating.

Module-4


Revised Bloom’s Taxonomy Level:
- L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing,
- L5 – Evaluating.

Module-5


Revised Bloom’s Taxonomy Level:
- L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing,
- L5 – Evaluating.
Course outcomes:
At the end of the course the student will be able to:
- Classify the signals and systems.
- Explain basic operations on signals and properties of systems.
- Use convolution in both continuous and discrete domain for the analysis of systems given the impulse response of a system.
- Evaluate response of a given linear time invariant system.
- Provide block diagram representation of a linear time invariant system.
- Apply continuous time Fourier transform representation to study signals and linear time invariant systems.
- Apply discrete time Fourier transform representation to study signals and linear time invariant systems. Use Z-transform and properties of Z transform for the analysis of discrete time systems.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Modern tool usage, Ethics.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Authors</th>
<th>Publisher</th>
<th>Edition</th>
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Reference Books

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<td>Subject Code</td>
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<tr>
<td>15EE551</td>
<td>20</td>
<td>40</td>
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</tbody>
</table>

**Course objectives:**

- To explain the fission process in nuclear materials and how the nuclear reactors work and the basic components of nuclear reactors and their types.
- Explanation about cooling of reactors, features of coolant, different types of coolants used in the reactors and the losses of cooling.
- Discussion on loss of cooling accidents in different reactors.
- Discussion on postulated severe accidents in water cooled reactors and other reactors and cooling of reactor during removal and processing.
- Discussion on cooling and disposing the nuclear waste and prospect of fusion energy in the future.

**Module-1**


**Module-2**

| Cooling Reactors: Introduction, General Features of a Reactor Coolant, Principles of Heat Transfer, Gaseous Coolants, Liquid Coolants, Boiling Coolants. | 08 |

**Module-3**

| Loss of Cooling Accidents: Introduction, Incidents in light Water-Cooled Reactors, Heavy Water-Moderated Reactors, Gas-Cooled Reactors, Liquid Metal-Cooled Fast Reactors. | 08 |

**Module-4**

| Postulated Severe Accidents Introduction: Introduction, Postulated Severe Accidents in Water-Cooled Reactors, Specific Phenomena relating to Severe Accidents, Severe Accidents in other Reactor Types, Fission Product Dispersion following Containment Failure. | 08 |

**Module-5**

| Cooling and Disposing of the Waste: Introduction, Classification of Waste Products, Fission Products and Their Biological Significance, Options for Nuclear Waste Disposal, Long-Term Storage and Disposal of Spent Nuclear Fuel, Storage and Disposal of Fission Products from Reprocessing Plants, Disposal of other Materials. | 08 |
**Course outcomes:**
At the end of the course the student will be able to:
- Explain the fission process in nuclear materials, basic components of nuclear reactors, types of nuclear reactors and their working.
- Discuss different types of coolants, their features, and cooling of reactors,
- Discuss loss of cooling accidents in different reactors.
- Discuss postulated severe accidents in reactors and cooling of reactor during removal of spent fuel.
- Discuss cooling and disposing the nuclear waste and prospect of fusion energy in the future.

**Graduate Attributes (As per NBA)**

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Textbook**

**Reference Books**
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

ELECTRICAL ENGINEERING MATERIALS (Professional Elective)

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</table>

Course objectives:
- To impart the knowledge of conducting, dielectric, insulating and magnetic materials and their applications.
- To impart the knowledge of superconducting materials and their applications
- To impart the knowledge of plastics and materials for Opto - Electronic devices.

Module-1


Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Module-2
Conductive Materials and Applications: Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing.

Dielectrics: Introduction to dielectric materials, classification of dielectric materials, Dielectric constant, Dielectric strength and Dielectric loss, Polarization, Mechanisms of polarization, Comparison of different polarization process, Factors affecting polarization, Spontaneous polarization, Behaviour of polarization under impulse and frequency switching, Decay and build-up of polarization under ac field, Complex dielectric constant.

Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Module-3


Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Module-4

Superconductive Materials: Concept of superconductors, Meaning of phenomenon of superconductivity, Properties of superconductors, Types of superconductors, Critical magnetic field

Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.
Module-4 (continued)

Superconductive Materials: and critical temperature, Effects of Isotopic mass on critical temperature, Silsbee rule, Depth of penetration and coherence length. Ideal and Hard superconductors, Mechanism of super conduction, London’s theory for Type I superconductors, GLAG theory for Type I superconductors, BCS theory, Applications and limitations. Applications of high temperature superconductors, Superconducting solenoids and magnets, MRI for medical diagnostics.

Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Module-5

Plastics: Introduction, Thermoplastics, Rubbers, Thermosets, DC and AC properties, Mechanical properties and processing of plastic.


Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Course outcomes:
At the end of the course the student will be able to:

- Discuss electrical and electronics materials, their importance, classification and operational requirement
- Discuss conducting materials used in engineering, their properties and classification.
- Discuss dielectric materials used in engineering, their properties and classification.
- Discuss insulating materials used in engineering, their properties and classification.
- Discuss magnetic materials used in engineering, their properties and classification.
- Explain the phenomenon superconductivity, super conducting materials and their application in engineering.
- Explain the plastic and its properties and applications.
- Discuss materials used for Opto electronic devices.

Graduate Attributes (As per NBA)
Engineering Knowledge

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook

<table>
<thead>
<tr>
<th>No.</th>
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<th>Edition</th>
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<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
</table>
Module-1


Revised Bloom’s Taxonomy Level | L1 – Remembering, L2 – Understanding.

Module-2

Wiring: Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Desirabilities of Wiring. Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables

Wiring (continued): Main Switch and Distribution Board, Conduits and its accessories and Fittings. Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse Units, Earthing Conductor.

Internal Wiring: General rules for wiring, Design of Lighting Points (Refer to Seventh Chapter of the Textbook), Number of Points, Determination of Total Load, Number of Sub – Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout ...


Module-3


Module-4

Estimation of Overhead Transmission and Distribution Lines: (Review of Line Supports, Conductor Materials, Size of Conductor for Overhead Transmission Line, Types of Insulators)[No Question Shall be Set From the Review Portion].


### Module-4 (continued)

<table>
<thead>
<tr>
<th>Estimation of Overhead Transmission and Distribution Lines (continued): Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulators, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead Lines, Clearances of Conductor From Ground, Spacing Between Conductors, Important Specifications.</th>
<th>08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing</td>
</tr>
</tbody>
</table>

### Module-5

<table>
<thead>
<tr>
<th>Estimation of Substations: Main Electrical connection, Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation main Connection Diagram, Single Line Diagram of Typical Substations, Equipment for Substation, Substation Auxiliaries Supply, Substation Earthing.</th>
<th>08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding</td>
</tr>
</tbody>
</table>

### Course outcomes:

At the end of the course the student will be able to:
- Explain the purpose of estimation and costing.
- Discuss market survey, estimates, purchase enquiries, preparation of tenders, comparative statements and payment of bills.
- Discuss Indian Electricity act and Indian Electricity rules.
- Discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses.
- Discuss design of lighting points and its number, total load, sub-circuits, size of conductor.
- Discuss types of service mains and estimation of service mains and power circuits.
- Discuss estimation of overhead transmission and distribution system and its components.
- Discuss main components of a substation, preparation of single line diagram of a substation and earthing of a substation.

### Graduate Attributes (As per NBA)

Engineering Knowledge,

### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Textbook

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER – V  
SPECIAL ELECTRICAL MACHINES (Professional Elective)  

<table>
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<th>15EE554</th>
<th>IA Marks</th>
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<td>Exam Hours</td>
<td>03</td>
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<tr>
<td>Total Number of Lecture Hours</td>
<td>40</td>
<td>Exam Marks</td>
<td>80</td>
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</tbody>
</table>

Credits – 03

Course Objectives:
- To impart knowledge on the Construction, principle of operation, control and performance of stepping motors.
- To impart knowledge on the Construction, principle of operation, control and performance of switched reluctance motors and permanent magnet brushless D.C. motors.
- To impart knowledge on the Construction, principle of operation and performance of permanent magnet synchronous motors and synchronous reluctance motor.
- To impart knowledge on single phase special machines and servo motors.
- To impart knowledge on Linear electrical machine and permanent magnet axial flux machines.

Module-1

Stepper Motor: Introduction, Variable Reluctance Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Other Types of Stepper Motor, Windings in Stepper Motors, Torque Equation, Characteristics of Stepper Motor, Open – loop Control of Stepper Motor, Closed – loop Control of Stepper Motor, Microprocessor – Based Control of Stepper Motor, Applications of Stepper Motor.

Revised Bloom’s Taxonomy Level

| L₁ – Remembering, L₂ – Understanding |

Module-2


Permanent Magnet DC Motor and Brushless Permanent Magnet DC Motor: Permanent Magnet DC (PMDC) motor, Brushless Permanent Magnet DC (BLDC) Motors.

Revised Bloom’s Taxonomy Level

| L₁ – Remembering, L₂ – Understanding |

Module-3


Synchronous Reluctance Motor (SyRM): Constructional of SyRM, Working, Phasor Diagram and Torque Equation, Control of SyRM, Advantages and Applications.

Revised Bloom’s Taxonomy Level

| L₁ – Remembering, L₂ – Understanding |

Module-4


Servo Motors: DC Servo Motors, AC Servo Motors.

Revised Bloom’s Taxonomy Level

| L₁ – Remembering, L₂ – Understanding |

Module-5

Linear Electric Machines: Linear Induction Motor, Linear Synchronous Motor, DC Linear Motor, Linear Reluctance Motor, Linear Levitation Machines.

Permanent Magnet Axial Flux (PMAF) Machines: Comparison of Permanent Radial and Axial Flux Machines, Construction of PMAF Machines, Armature Windings, torque and EMF Equations of PMAF, Phasor Diagram, Output Equation, Pulsating Torque And Its Minimisation, Control and Applications of PMAF.

Revised Bloom’s Taxonomy Level

| L₁ – Remembering, L₂ – Understanding |
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V
15EE554  SPECIAL ELECTRICAL MACHINES (Professional Elective) (continued)

**Course outcomes:**
At the end of the course the student will be able to:
- Explain the performance and control of stepper motors, and their applications.
- Explain theory of operation and control of switched reluctance motor and permanent magnet brushless D.C. motors.
- Explain theory of operation and control of permanent magnet synchronous motors and synchronous reluctance motor.
- Explain operation of single phase special machines and servo motors.
- Explain operation of linear electrical machine and permanent magnet axial flux machines.

**Graduate Attributes (As per NBA):**
Engineering Knowledge, Problem analysis.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

**Textbook**
<table>
<thead>
<tr>
<th></th>
<th>Special Electrical Machines</th>
<th>E.G. Janardanan</th>
<th>PHI</th>
<th>1st Edition 2014</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Special Electrical Machines</td>
<td>K Venkataraman</td>
<td>University Press</td>
<td>2009</td>
</tr>
<tr>
<td>3</td>
<td>Permanent Magnet and Brushless DC Motors</td>
<td>Kenjo T and Nagamori S</td>
<td>Clerendon Press, Oxford</td>
<td>1985</td>
</tr>
<tr>
<td>4</td>
<td>Stepping Motors and their Microprocessor Control</td>
<td>Kenjo T</td>
<td>Clerendon Press Oxford</td>
<td>1984</td>
</tr>
<tr>
<td>5</td>
<td>Switched Reluctance Motor Drives Modeling, Simulation Design and Applications</td>
<td>Krishan R</td>
<td>CRC</td>
<td>2001</td>
</tr>
</tbody>
</table>

**Reference Books**
Course objectives:

- To explain elements of communication system, noise and its effects.
- To describe the theory of amplitude, angle, pulse and digital modulation techniques
- To explain principles of radio communication, transmitters and receivers
- To explain basics of Television Broadcasting
- To explain basic principles of radar systems.
- To discuss multiplexing used in broadband communications.
- To explain the basic routing process used for long-distance telephony
- To explain fiber optic technology used for communication and its components and systems and their installation.
- To discuss basics of information theory, coding and data communication.

Module 1


Noise: External Noise, internal Noise, Noise Calculations, Noise Figure, Noise Temperature.


Module 2

Module-2


Module 3


Module 4


Revised Bloom’s Taxonomy Level

### Module-5

**Teaching Hours:** 08

#### 15EE561 ELECTRONIC COMMUNICATION SYSTEMS (Open Elective) (continued)

<table>
<thead>
<tr>
<th>Module-5</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction to Fiber Optic Technology:</strong> History of Fiber Optics, Need of Optical Fibers, Introduction to Light, The Optical Fiber and Fiber Cables, Fiber Optic Components and Systems, Installation, Testing, and Repair.</td>
<td></td>
</tr>
<tr>
<td><strong>Information Theory, Coding and Data Communication:</strong> Information Theory, Digital Codes, Error Detection and Correction, Fundamentals of Data Communication System, Data Sets and Interconnection Requirements, Network and Control Considerations.</td>
<td></td>
</tr>
</tbody>
</table>

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing |

#### Course outcomes:

At the end of the course the student will be able to:

- Understand communication systems and its terminologies.
- Explain noise, computation of noise level in communication systems.
- Describe the theory of amplitude, angle, pulse and digital modulation techniques.
- Explain principles of radio communication, transmitters and receivers.
- Show understanding of the basic TV system and process transmission and reception.
- Explain basic principles of radar systems and multiplexing broadband communication systems.
- Show understanding of fiber optic technology.
- Show understanding of information theory, coding and data communication.

#### Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations, Life-long Learning.

#### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

#### Textbook


#### Reference Books

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - V  

PROGRAMMABLE LOGIC CONTROLLERS (Open Elective)  

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>15EE562</th>
<th>IA Marks</th>
<th>20</th>
<th>Exam Hours</th>
<th>03</th>
<th>Exam Marks</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Lecture Hours/Week</td>
<td>03</td>
<td>Total Number of Lecture Hours</td>
<td>40</td>
<td>Credits</td>
<td>03</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Course objectives:
- To explain advantages and disadvantages, main parts and their functions, basic sequence of operation of PLC.
- To describe the hardware components: I/O modules, CPU, memory devices, other support devices and the functions of PLC memory map.
- To describe program scan sequence, the communication of information to the PLC using different languages, internal relay instruction.
- To explain identification of common operating modes found in PLCs, writing and entering the ladder logic programs.
- To define the functions of Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits and Latching Relays.
- To explain conversion of relay schematics into PLC ladder logic programs and writing PLC programs directly from narrative descriptions.
- To explain the functions of PLC counter instructions, applying combinations of counters and timers to control systems.
- To describe the function of selectable timed interrupt and fault routine files and use of temporary end instruction.
- To explain the execution of data transfer instructions, interruption of data transfer and data compare instructions.
- To explain the basic operation of PLC closed-loop control system, various forms of mechanical sequencers and their operations.
- To describe the operation of bit and word shift registers and develop programs that use shift registers.
- To discuss the operation of various processes, structures of control systems and the method of communication between different industrial processes.

Module-1

Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application.
PLC Hardware Components: The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).
Basics of PLC Programming: Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of Operation

Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, |
|-------------------------------|---------------------------------|

Module-2

Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description.
Programming Timers: Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers

Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, |
Module-3

**Programming Counters:** Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions.

**Program Control Instructions:** Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction.

Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding,

Teaching Hours
08

Module-4

**Data Manipulation Instructions:** Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control.

**Math Instructions:** Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations.

Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Teaching Hours
08

Module-5

**Sequencer and Shift Register Instructions:** Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations.

**Process Control, Network Systems, and SCADA:** Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA).

Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Teaching Hours
08

Course outcomes:
At the end of the course the student will be able to:
- Discuss history of PLC, its sequence of operation, advantages and disadvantages, main parts and their functions.
- Describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.
- Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module.
- Convert relay schematics and narrative descriptions into PLC ladder logic programs.
- Analyze PLC timer and counter ladder logic programs.
- Describe the operation of different program control instructions.
- Discuss the execution of data transfer instructions, data compare instructions and the basic operation of PLC closed-loop control system.
- Describe the operation of mechanical sequencers, bit and word shift registers, processes and structure of control systems and communication between the processes.

Graduate Attributes (As per NBA)
Engineering Knowledge

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.
<table>
<thead>
<tr>
<th>Textbook</th>
<th>Reference Book</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Programmable Logic Controllers</td>
<td>1 Programmable Logic Controllers an Engineer’s Guide,</td>
</tr>
<tr>
<td>Frank D Petruzella</td>
<td>E A Parr</td>
</tr>
<tr>
<td>2 Introduction Programmable Logic</td>
<td>Introduction Programmable Logic Controllers</td>
</tr>
<tr>
<td>Controllers</td>
<td>Gary Dunning</td>
</tr>
<tr>
<td></td>
<td>Cengage</td>
</tr>
</tbody>
</table>
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
**CHOICE BASED CREDIT SYSTEM (CBCS)**  
**SEMESTER - V**  
### RENEWABLE ENERGY RESOURCES (Open Elective)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Hours</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
<th>Credits</th>
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<tbody>
<tr>
<td>15EE563</td>
<td>20</td>
<td>03</td>
<td>03</td>
<td>40</td>
<td>8</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course objectives:**
- To discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- To discuss solar energy reaching the Earth’s surface and solar thermal energy applications.
- To discuss types of solar collectors, their configurations and their applications.
- To explain the components of a solar cell system, equivalent circuit of a solar cell, its characteristics and applications.
- To discuss benefits of hydrogen energy, production of hydrogen energy, storage its advantages and disadvantages.
- To discuss wind turbines, wind resources, site selection for wind turbine.
- To discuss geothermal systems, their classification and geothermal based electric power generation.
- To discuss waste recovery management systems, advantages and disadvantages.
- To discuss biomass production, types of biomass gasifiers, properties of producer gas.
- To discuss biogas, its composition, production, benefits.
- To discuss tidal energy resources, energy availability, power generation.
- To explain motion in the sea wave, power associated with sea wave and energy availability and the devices for harnessing wave energy.
- To discuss principles of ocean thermal energy conversion and production of electricity.

#### Module-1


**Energy from Sun:** Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth’s Surface, Solar Thermal Energy Applications.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

#### Module-2


Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

#### Module-3


**Wind Energy:** Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection.


Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.
<table>
<thead>
<tr>
<th>Module-3 (continued)</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revised Bloom’s Taxonomy Level</strong></td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-4</th>
<th>08</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biogas Energy:</strong> Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics.</td>
<td></td>
</tr>
<tr>
<td><strong>Revised Bloom’s Taxonomy Level</strong></td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-5</th>
<th>08</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sea Wave Energy:</strong> Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power.</td>
<td></td>
</tr>
<tr>
<td><strong>Revised Bloom’s Taxonomy Level</strong></td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</td>
</tr>
</tbody>
</table>

**Course outcomes:**
At the end of the course the student will be able to:
- Discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- Discuss energy from sun, energy reaching the Earth’s surface and solar thermal energy applications.
- Discuss types of solar collectors, their configurations, solar cell system, its characteristics and their applications.
- Discuss generation of energy from hydrogen, wind, geothermal system, solid waste and agriculture refuse.
- Discuss production of energy from biomass, biogas.
- Discuss tidal energy resources, energy availability and power generation.
- Discuss power generation sea wave energy and ocean thermal energy.

**Graduate Attributes (As per NBA)**
Engineering Knowledge, Problem Analysis, Modern tool usage, Ethics.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
<table>
<thead>
<tr>
<th>Textbook</th>
<th>Title</th>
<th>Author</th>
<th>Publisher</th>
<th>Edition, Year</th>
</tr>
</thead>
</table>
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
**CHOICE BASED CREDIT SYSTEM (CBCS)**
**SEMESTER - V**

**BUSINESS COMMUNICATION (Open Elective)**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>03</th>
<th>Exam Hours</th>
<th>03</th>
<th>Total Number of Lecture Hours</th>
<th>40</th>
<th>Exam Marks</th>
<th>80</th>
</tr>
</thead>
</table>

**Credits - 03**

**Course Objectives:**
- To discuss analyzing audiences, and choose the most effective structure and style for delivering strategically sound written and spoken messages.
- To discuss how to organize the talk, handling audience response.
- To discuss how to communicate with managers, co-workers, customers and suppliers.
- To discuss how engineers can use written and oral skills, computer, graphics and other engineering tools to communicate with other engineers and management.

**Module-1**

**Analyze Communication Purpose and Audience:** How to Learn, How Engineers Are Persuaded, Speak or Write: Select the Right Communication Channel, Consider Your Communication Purpose and Audience.

**Projecting the Image of the Engineering Profession:** Overcome Anxiety, Primary Impact: Nonverbal Body Language, Secondary Impact: Control Vocal Quality, Volume, And Pace, Optimize Presentation Environment.


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>

**Module-2**

**Organize Your Talk:** Planning Your Talk, Conducting an Audience Analysis: 39Questions, Organizing Your Talking Seven Easy Stages, Getting Attention and Keeping Interest, Five Minutes Early – Time Management for Your Presentation, Delivering Your Introduction, Presenting Your Conclusion.

**Handling Audience Response:** Create the Environment, Handle with C.A.R.E, Deal with Hostile Questions, Deal with Other Types of Questions, Control the Q&A Session, Thinking on Your Feet.

**Organizing for Emphasis:** Make our Bottom Line the Top Line, Purpose Statement and Blueprints, Open Long Reports with a Summary, Use More Topic Sentences, Develop Headings, Structure Vertical Lists.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

**Module-3**

**Write As If Talking to Your Engineering Associates:** Use Personal Pronouns, Rely on Everyday Words, Use Short Spoken Transitions, Keep Sentences Short, Reach Out to Your Engineering Readers by Asking Questions, 5Whys-ATechnique for Engineering Problem Solving.

**Trim Your Expressions:** Introduction, Prune Wordy Expressions, Use Strong Verbs, Cut Doublings and Noun Strings, Eliminate Unnecessary Determiners and Modifiers, Change Phrases into Single Words, Change Unnecessary Clauses into Phrases or Single Words, Avoid Over using “IIts” and “Thereis”, Eight Steps for Lean Writing.

**Write Actively—Engineering is about Actions:** Active Voice: “Albert Einstein Wrote the Theory of Relativity”, How to Recognize the Passive Voice, How to Write Actively – Use Three Cures, Write Passively for Good Reasons Only, Theory of Completed Staff Work.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

**Module-4**

**Every day Engineering Communications -E-MAILS, Phone Calls, and Memos:** Effective E-mail Writing: Seven Things to Remember, How to Be Productive on the Phone, “Memos Solve Problems”.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. | 08 |

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module-4 (continued)

<table>
<thead>
<tr>
<th>Teaching Hours</th>
<th>Visuals for Engineering Presentation - Engineers Think in Pictures: Optimize Slide Layout, Display Engineering Data Effectively, How to Develop Effective Graphics. Write Winning Grant Proposals: Know Your Audience, Understand Your Goal and Marketing Strategy, Select the Correct Writing Style, Organize Your Proposal around the FourPs, A Brief Checklist before Submitting Your Proposal.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Module-5

|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Course outcomes:

At the end of the course the student will be able to:
- Apply business communication strategies and principles to prepare effective communication for domestic and international business situations.
- Utilize analytical and problem solving skills appropriate to business communication.
- Participate in team activities that lead to the development of collaborative work skills.
- Select appropriate organizational formats and channels used in developing and presenting business messages.
- Compose and revise accurate business documents using computer technology.
- Communicate via electronic mail, Internet, and other technologies.
- Deliver an effective oral business presentation.

### Graduate Attributes (As per NBA)

**Engineering Knowledge**

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Book**

| 1 | What Every Engineer Should Know About Business Communication | John X. Wang | CRC | 2008 |
Subject Code: 15EEL57

Number of Practical Hours/Week: 0

Total Number of Practical Hours: 42

Credits: 02

Course objectives:
- To explain writing assembly language programs for data transfer, arithmetic, Boolean and logical instructions.
- To explain writing assembly language programs for code conversions.
- To explain writing assembly language programs using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.
- To perform interfacing of stepper motor and dc motor for controlling the speed.
- To explain generation of different waveforms using DAC interface.

Experiments

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data transfer – Program for block data movement, sorting, exchanging, finding largest element in an array.</td>
</tr>
<tr>
<td>2</td>
<td>Arithmetic instructions: Addition, subtraction, multiplication and division. Square and cube operations for 16 bit numbers.</td>
</tr>
<tr>
<td>3</td>
<td>Counters</td>
</tr>
<tr>
<td>4</td>
<td>Boolean and logical instructions (bit manipulation).</td>
</tr>
<tr>
<td>5</td>
<td>Conditional call and return instructions.</td>
</tr>
<tr>
<td>6</td>
<td>Code conversion programs – BCD to ASCII, ASCII to BCD, ASCII to decimal, Decimal to ASCII, Hexadecimal to and Decimal to Hexa.</td>
</tr>
<tr>
<td>7</td>
<td>Programs to generate delay. Programs using serial port and on-chip timer/counters.</td>
</tr>
</tbody>
</table>

Note: For the experiments 1 to 6, 8051 assembly programming is to be used.

Note: Single chip solution for interfacing 8051 is to be with C Programs for the following experiments.

8     | Stepper motor interface. |
| 9     | DC motor interface for direction and speed control using PWM. |
| 10    | Alphanumeric LCD panel interface. |
| 11    | Generate different waveforms: Sine, Square, Triangular, Ramp using DAC interface. |
| 12    | External ADC and Temperature control interface. |
| 13    | Elevator interface. |

Revised Bloom’s Taxonomy Level


Course outcomes:
At the end of the course the student will be able to:
- Write assembly language programs for data transfer, arithmetic, Boolean and logical instructions.
- Write ALP for code conversions.
- Write ALP using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.
- Perform interfacing of stepper motor and dc motor for controlling the speed.
- Generate different waveforms using DAC interface.
- Work with a small team to carryout experiments using microcontroller concepts and prepare reports that present lab work.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Modern tool usage, Communication.
**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Learning beyond the syllabus:** To acquire a wide variety of skills and to develop society friendly applications mini projects can be practiced by referring to “Microcontroller Based Projects” Second Edition, An EFY (Electronics For You) Enterprise Pvt Ltd, 2013.
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - V  

POWER ELECTRONICS LABORATORY

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Practical Hours/Week</th>
<th>Exam Hours</th>
<th>Total Number of Practical Hours</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EEL58</td>
<td>20</td>
<td>03</td>
<td>03</td>
<td>42</td>
<td>80</td>
</tr>
</tbody>
</table>

Credits - 02

Course objectives:
- To conduct experiments on semiconductor devices to obtain their static characteristics.
- To study different methods of triggering the SCR.
- To study the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
- To control the speed of a dc motor, universal motor and stepper motors.
- To study single phase full bridge inverter connected to resistive load.
- To study commutation of SCR.

Course outcomes:
At the end of the course the student will be able to:
- Obtain static characteristics of semiconductor devices to discuss their performance.
- Trigger the SCR by different methods.
- Verify the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
- Control the speed of a dc motor, universal motor and stepper motors.
- Verify the performance of single phase full bridge inverter connected to resistive load.
- Perform commutation of SCR by different methods.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
VI SEMESTER DETAILED SYLLABUS
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - VI  
CONTROL SYSTEMS (Core Subject)  

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Hours</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE61</td>
<td></td>
<td>03</td>
<td>50</td>
<td>80</td>
</tr>
</tbody>
</table>

**Credits - 04**

### Course objectives:
- To define a control system
- To explain the necessity of feedback and types of feedback control systems.
- To introduce the concept of transfer function and its application to the modeling of linear systems.
- To demonstrate mathematical modeling of control systems.
- To obtain transfer function of systems through block diagram manipulation and reduction
- To use Mason’s gain formula for finding transfer function of a system
- To discuss transient and steady state time response of a simple control system.
- To discuss the stability of linear time invariant systems and Routh - Hurwitz criterion
- To investigate the trajectories of the roots of the characteristic equation when a system parameter is varied.
- To conduct the control system analysis in the frequency domain.
- To analyze stability of a control system using Nyquist plot.
- To discuss stability analysis using Bode plots.
- To determine the controller or compensator configuration and parameter values relative to how it is connected to the controlled process given the design specifications.

### Module-1

<table>
<thead>
<tr>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

**Introduction to control systems:** Introduction, classification of control systems.

**Mathematical models of physical systems:** Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains.

|--------------------------------|---------------------------------------------------------------------|

### Module-2

<table>
<thead>
<tr>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

**Block diagram:** Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function.

**Signal flow graphs:** Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.

|--------------------------------|---------------------------------------------------------------------|

### Module-3

<table>
<thead>
<tr>
<th>Teaching Hours</th>
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</thead>
<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

**Time Domain Analysis:** Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems.

**Routh Stability criterion:** BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis.

|--------------------------------|---------------------------------------------------------------------|

### Module-4

<table>
<thead>
<tr>
<th>Teaching Hours</th>
</tr>
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<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

**Root locus technique:** Introduction, root locus concepts, construction of root loci, rules for the construction of root locus.

**Frequency Response analysis:** Co-relation between time and frequency response – 2nd order systems only.

**Bode plots:** Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin.

|--------------------------------|---------------------------------------------------------------------|
## Module-5

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Design of Control Systems:</td>
<td>Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lag Controller, Design with Phase-Lead Controller.</td>
</tr>
</tbody>
</table>

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Course outcomes:
At the end of the course the student will be able to:
- Discuss the effects of feedback and types of feedback control systems.
- Evaluate the transfer function of a linear time invariant system.
- Evaluate the stability of linear time invariant systems.
- Apply block diagram manipulation and signal flow graph methods to obtain transfer function of systems.
- Demonstrate the knowledge of mathematical modeling of control systems and components.
- Determine transient and steady state time response of a simple control system.
- Investigate the performance of a given system in time and frequency domains.
- Discuss stability analysis using Root locus, Bode plots and Nyquist plots.
- Determine the controller or compensator configuration and parameter values relative to how it is connected to the controlled process given the design specifications.

### Graduate Attributes (As per NBA)
Engineering Knowledge, Problem analysis, Modern Tool Usage, Life-long Learning.

### Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

### Textbook

<table>
<thead>
<tr>
<th>Textbook</th>
<th>Anand Kumar</th>
</tr>
</thead>
</table>

### Reference Books

<table>
<thead>
<tr>
<th>Reference Books</th>
<th></th>
<th></th>
</tr>
</thead>
</table>
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
### CHOICE BASED CREDIT SYSTEM (CBCS)
### SEMESTER - VI

**POWER SYSTEM ANALYSIS – I (Core Subject)**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE62</td>
<td>20</td>
<td>03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>80</td>
</tr>
</tbody>
</table>

**Credits - 04**

### Course objectives:
- To introduce the per unit system and explain its advantages and computation.
- To explain the concept of one line diagram and its implementation in problems.
- To explain the necessity and conduction of short circuit analysis.
- To explain analysis of three phase symmetrical faults on synchronous machine and simple power systems.
- To discuss selection of circuit breaker.
- To explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits.
- To explain the concept of sequence impedance and its analysis in three phase unbalanced circuits.
- To explain the concept of sequence impedances and sequence impedances of an unloaded synchronous generator, transformers and transmission lines.
- To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- To discuss the dynamics of synchronous machine and derive the power angle equation for a synchronous machine.
- Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system.

### Module-1

#### Representation of Power System Components:

**Revised Bloom’s Taxonomy Level**


### Module-2

#### Symmetrical Fault Analysis:

**Revised Bloom’s Taxonomy Level**


### Module-3

#### Symmetrical Components:

**Revised Bloom’s Taxonomy Level**


### Module-4

#### Unsymmetrical Fault Analysis:

**Revised Bloom’s Taxonomy Level**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI

15EE62 POWER SYSTEM ANALYSIS – I (Core Subject) (continued)

<table>
<thead>
<tr>
<th>Module-5</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
</tr>
</tbody>
</table>

### Course outcomes:
At the end of the course the student will be able to:

- Show understanding of per unit system, its advantages and computation.
- Show the concept of one line diagram and its implementation in problems
- Perform short circuit analysis on a synchronous machine and simple power system to select a circuit breaker for the system.
- Evaluate symmetrical components of voltages and currents in un-balanced three phase circuits.
- Explain the concept of sequence impedance and sequence networks of power system components and power system.
- Analyze three phase synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- Discuss the dynamics of synchronous machine, stability and types of stability.
- Discuss equal area criterion for the evaluation of stability of a simple system under different fault conditions.

### Graduate Attributes (As per NBA)
Engineering Knowledge, Problem analysis, The Engineer and Society, Ethics

### Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

### Textbook

|------------------------|--------------|-------------|------------------|

### ReferenceBooks

## Module 1
### Discrete Fourier Transforms
Definitions, properties-linearity, shift, symmetry
- Circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stockham’s method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating</th>
</tr>
</thead>
</table>

### Module 2
### Fast Fourier Transforms Algorithms
Introduction, decimation in time algorithm, first decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithms, Inverse radix – 2 algorithms.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating</th>
</tr>
</thead>
</table>

### Module 3
### Design of IIR Digital Filters
Introduction, impulse invariant transformation, bilinear transformations, All pole analog filters- Butterworth & Chebyshev filters, design of digital Butterworth filter by impulse invariant transformation and bilinear transformation, Frequency transformations.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L1- Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating</th>
</tr>
</thead>
</table>

### Module 4
### Design of IIR Digital Filters (Continued)
Design of digital Chebyshev – type 1 filter by impulse invariant transformation and bilinear transformation, Frequency transformations.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating</th>
</tr>
</thead>
</table>

### Course objectives:
- To define Discrete Fourier transform and its properties.
- To evaluate DFT of various signals using properties of DFT.
- To explain different linear filtering techniques.
- To explain the evaluation of DFT and inverse DFT using fast and efficient algorithms.
- To discuss impulse invariant transformation, bilinear transformation techniques and their properties.
- To design infinite impulse response Butterworth digital filters using impulse invariant and bilinear transformation techniques.
- To design infinite impulse response Chebyshev digital filters using impulse invariant and bilinear transformation techniques.
- To discuss direct, cascade, parallel and ladder methods of realizing a digital IIR filter.
- To discuss window functions used for the design of FIR filters.
- To discuss windowing technique of designing FIR filter.
- To discuss frequency sampling technique of designing FIR filter.
- To discuss direct, cascade and linear phase form of realizing a digital FIR filter.
Module-5

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Realization of FIR systems:</td>
<td>direct form, cascade form, linear phase form</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing, L₅– Evaluating</td>
</tr>
<tr>
<td>Teaching Hours</td>
<td>10</td>
</tr>
</tbody>
</table>

**Course outcomes:**
At the end of the course the student will be able to:
- Compute the DFT of various signals using its properties and linear filtering of two sequences.
- Apply fast and efficient algorithms for computing DFT and inverse DFT of a given sequence.
- Design infinite impulse response Chebyshev digital filters using impulse invariant or bilinear transformation technique.
- Realize a digital IIR filter by direct, cascade, parallel and ladder methods of realization.
- Discuss different window functions and frequency sampling method used for design of FIR filters.
- Design FIR filters by use of window function or by frequency sampling method.
- Realize a digital FIR filter by direct, cascade, and linear phase form. ■

**Graduate Attributes (As per NBA)**
Engineering Knowledge, Problem analysis, Design/ Development of Solutions, Modern Tool Usage.

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

**Textbook**


**Reference Books**

## Course objectives:
- To discuss design factors, limitations in design and modern trends in design and manufacturing of electrical machines.
- To discuss the properties of electrical, magnetic and insulating materials used in the design of electrical machines.
- To derive the output equation of DC machine, single phase, three phase transformers, induction motor and synchronous machines.
- To discuss the selection of specific loadings, for various machines.
- To discuss separation of main dimensions for different electrical machines.
- To discuss design of field windings for DC machines and synchronous machines.
- To evaluate the performance parameters of transformer, induction motor.
- To design of cooling tubes for the transformer for a given temperature rise.
- To explain design of rotor of squirrel cage rotor and slip ring rotor.
- To define short circuit ratio and discuss its effect on machine performance.

### Module-1

**Fundamental Aspects of Electrical Machine Design:** Design of Machines, Design Factors, Limitations in design, Modern Trends in design, Manufacturing Techniques.


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-2


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-3

**Design of Transformers:** Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-4


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>
Module-5  


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L1 – Applying, L4 – Analysing, L2 – Understanding, L4 – Analysing.</th>
</tr>
</thead>
</table>

**Course outcomes:** At the end of the course the student will be able to:
- Discuss design factors, limitations, modern trends in design, manufacturing of electrical machines and properties of materials used in the electrical machines.
- Derive the output equations of transformer, DC machines and AC machines.
- Discuss selection of specific loadings and magnetic circuits of different electrical machines.
- Design the field windings of DC machine and Synchronous machine.
- Design stator and rotor circuits of a DC and AC machines.
- Estimate the number of cooling tubes, no load current and leakage reactance of core type transformer.
- Discuss short circuit ratio and its effects on performance of synchronous machines.
- Design salient pole and non-salient pole alternators for given specifications.  

**Graduate Attributes (As per NBA)**
Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Ethics.  

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.  

**Textbook**


**Reference Books**

| 1 | Performance and Design of Alternating Current Machines | M.G. Say | CBS Publisher | 3rd Edition, 2002 |
Course objectives:

- To discuss the terminology of DC and AC armature windings.
- To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
- To discuss the substation equipment, their location in a substation and development of a layout for substation.
- To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
- To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches.

Suitable CAD software can be used for drawings

PART - A

Module-1

Winding Diagrams:
(a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.
(b) Developed Winding Diagrams of A.C. Machines:
(c) Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.
(d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings.

Revised Bloom’s Taxonomy Level

L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

Module-2


Revised Bloom’s Taxonomy Level


PART - B

Module-3

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:
Transformers - Sectional Views Of Single And Three Phase Core And Shell Type Transformers.

Revised Bloom’s Taxonomy Level


Module-4

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:

Revised Bloom’s Taxonomy Level


Module-5

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:
Alternator – Sectional Views of Stator and Rotor dealt separately.

Revised Bloom’s Taxonomy Level

Course Outcomes: At the end of the course the student will be able to:
- Discuss the terminology and types of DC and AC armature windings.
- Develop armature winding diagram for DC and AC machines.
- Develop a layout for substation using the standard symbols for substation equipment.
- Draw sectional views of core and shell types transformers using the design data.
- Draw sectional views of assembled DC machine or its parts using the design data or the sketches.
- Draw sectional views of assembled alternator or its parts using the design data or the sketches.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Modern tool usage, Ethics.

Question paper pattern:
- The question paper will have two parts, PART – A and PART – B.
- Each part is for 40 marks.
- Part A is for Modules 1 and 2.
- Questions 1 and 2 of PART – A will be only on DC windings or only on AC windings. Students have to answer any one of them. The marks prescribed is 25.
- Question 3 of PART – A covering module 2 is compulsory. The marks prescribed is 15.
- Part B is for Modules 3, 4 and 5.
- Questions 4 and 5 will cover any two modules of modules 3, 4 and 5. Students have to answer any one of them. The marks prescribed is 40.

Reference Books
1. A course in Electrical Machine design
   A. K. Sawhney
   Dhanpat Rai

2. Electrical Engineering Drawing
   K. L. Narang
   Satya Prakashan
   2014
### Course objectives:
- To study switching mode regulators and Boost converters, Resonant Pulse Inverters and multilevel inverters.
- To learn the techniques for design and analysis of dc–dc converters, Resonant Pulse Inverters and multilevel inverters.
- To explain the operation and frequency characteristics of resonant inverters and the techniques for zero-voltage and zero-current switching.
- To study the performance parameters of resonant inverters.
- To explain the techniques for analyzing and design of resonant inverters.
- To explain the operation and features of multilevel inverters, their advantages and disadvantages.
- To explain the control strategy to address capacitor voltage unbalancing.
- To discuss potential applications of multilevel inverters.
- To study the types and circuit topologies of power supplies and explain the operation and analysis of power supplies.
- To study the applications of power electronic devices.

### Module-1
**DC–DC Converters:** Switching-Mode Regulators, Comparison of Regulators, Multi-output Boost Converter, Diode Rectifier-Fed Boost Converter, Averaging Models of Converters, State-Space Analysis of Regulators, Design Considerations for Input Filter and Converters, Drive IC for Converters.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
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</thead>
<tbody>
<tr>
<td>L₁ – Remembering, L₂ – Understanding, L₄ – Analysing.</td>
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</tr>
</tbody>
</table>

### Module-2
**Resonant Pulse Inverters:** Introduction. Series Resonant Inverters, Frequency Response of Series Inverters, Parallel Resonant Inverters, Voltage Controlled Resonant Inverters, Class E Resonant Inverter, Class E Resonant Rectifier, Zero – Current Switching (ZCS) Resonant Converters, Zero Voltage Switching Resonant Converters (ZVS), Comparison between ZCS and ZVS Resonant Converters, Two Quadrant ZVS Resonant Converters, Resonant DC – Link Inverters.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
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</thead>
<tbody>
<tr>
<td>L₁ – Remembering, L₂ – Understanding, L₄ – Analysing.</td>
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</tbody>
</table>

### Module-3
**Multilevel Inverters:** Introduction, Multilevel Concept, Types of Multilevel Inverters, Diode – Clamped Multilevel Inverter, Flying – Capacitors Multilevel Inverter, Cascaded Multilevel Inverter, Applications, Features of Multilevel Inverters, Comparison of Multilevel Converters.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
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</thead>
<tbody>
<tr>
<td>L₁ – Remembering, L₂ – Understanding, L₄ – Analysing.</td>
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</table>

### Module-4
**Power Supplies:** Introduction, DC Power Supplies, AC Power Supplies, Multistage Conversions, Control Circuits, Magnetic Design Considerations.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
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</thead>
<tbody>
<tr>
<td>L₁ – Remembering, L₂ – Understanding, L₄ – Analysing.</td>
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</tbody>
</table>
### Module-5

<table>
<thead>
<tr>
<th>Residential and Industrial Applications:</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction, Residential Applications, Industrial Applications.</td>
<td>08</td>
</tr>
</tbody>
</table>

**Electrical Utility Applications:** Introduction, High Voltage DC Transmission, Static VAR Compensators, Interconnection of Renewable Energy Sources and Energy Storage systems to the Utility Grid, Active Filters.

**Revised Bloom’s Taxonomy Level**

| L₁ – Remembering, L₂ – Understanding, L₄ – Analysing |

#### Course Outcomes:

At the end of the course the student will be able to:

- Explain the types of switching – mode regulators, Resonant Pulse Inverters and multilevel inverters
- To discuss the techniques for design and analysis of dc –dc converters, Resonant Pulse Inverters and multilevel inverters
- Evaluate the performance parameters of resonant inverters
- Explain the techniques for zero-voltage and zero-current switching of resonant pulse inverters
- Explain the control strategy to address capacitor voltage unbalancing in multilevel inverters.
- Discuss the types, topologies operation and analysis of power supplies.
- Discuss residential, Industrial and Electrical utility applications of power electronic devices.

#### Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis Design/ Development of Solutions, Conduct investigations of complex problems, Ethics

#### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

#### Textbook

| 2 | Power Electronics Converters, Applications and Design (For Module 5: Chapters 16 and 17), Ned Mohan et al | Wiley | 3rd Edition, 2014 |

#### Reference Books

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE653</td>
<td>20</td>
<td>03</td>
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</tbody>
</table>
Module-5

<table>
<thead>
<tr>
<th>Energy Audit Applied to Buildings</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.</td>
<td>08</td>
</tr>
</tbody>
</table>

**Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM, customer acceptance, implementation issues, Implementation strategies, DSM and Environment.


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
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</thead>
<tbody>
<tr>
<td>L₁ - Remembering, L₂ - Understanding, L₃ - Applying, L₄ - Analysing</td>
<td></td>
</tr>
</tbody>
</table>

**Course outcomes:**
At the end of the course the student will be able to:
- Understand the need of energy audit and energy audit methodology.
- Explain audit parameters and working principles of measuring instruments used to measure the parameters.
- Conduct energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems.
- Conduct energy audit HVAC systems, motors, pumps, blowers and cooling towers.
- Explain load management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission.
- Conduct energy audit of lighting systems and buildings.
- Show an understanding of demand side management and energy conservation.

**Graduate Attributes (As per NBA)**
Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Environment and sustainability, Ethics, Individual and Team work, Communication

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Textbook**

<p>| | |</p>
<table>
<thead>
<tr>
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</table>
**B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – VI**

**SOLAR AND WIND ENERGY (Professional Elective)**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>15EE654</th>
<th>IA Marks</th>
<th>20</th>
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<tbody>
<tr>
<td>Number of Lecture Hours/Week</td>
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<tr>
<td>Total Number of Lecture Hours</td>
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<td>Exam Marks</td>
<td>08</td>
</tr>
<tr>
<td><strong>Credits – 03</strong></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Course objectives:**

- To discuss the importance of energy in human life, relationship among economy and environment with energy use.
- To discuss the increasing role of renewable energy, energy management, energy audit, energy efficiency, energy intensity.
- To discuss energy consumption status in India, energy saving potential and energy conservation efforts in India.
- To explain the concept of energy storage and the principles of energy storage devices.
- To discuss the characteristics and distribution of solar radiation, measurement of components of solar radiation and analysis of collected solar radiation data.
- To explain availability of solar radiation at a location and the effect of tilting the surface of collector with respect to horizontal surface.
- To describe the process of harnessing solar energy in the form of heat and working of solar collectors.
- To discuss applications of solar energy including heating and cooling.
- To discuss the operation of solar cell and the environmental effects on electrical characteristics of solar cell.
- To discuss sizing and design of typical solar PV systems and their applications.
- To discuss basic Principles of Wind Energy Conversion and to compute the power available in the wind.
- To discuss forces on the Blades, Wind Energy Conversion, collection of Wind Data, energy estimation and site selection.
- To discuss classification of WEC Systems, its advantages and disadvantages of WECS, and Types of Wind Machines (Wind Energy Collectors).
- To evaluate the performance of Wind-machines, Generating Systems.
- To discuss energy storage, applications of Wind Energy and Environmental Aspects.

<table>
<thead>
<tr>
<th>Module-1</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fundamentals of Energy Science and Technology:</strong> Introduction, Energy, Economy and Social Development, Classification of Energy Sources, Importance of Non -conventional Energy Sources, Salient features of Non-conventional Energy Sources, World Energy Status, Energy Status in India.</td>
<td>08</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</td>
</tr>
<tr>
<td>Module-2</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
</tr>
</tbody>
</table>
### Module-3


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-4


**Wind Energy Systems:** Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

### Module-5


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>

### Course Outcomes:

At the end of the course the student will be able to:

- Discuss the importance of energy in human life, relationship among economy and environment with energy use and the increasing role of renewable energy.
- Explain the concept of energy storage and the principles of energy storage devices.
- To discuss solar radiation on horizontal and tilted surface, its characteristics, measurement and analysis of radiation data.
- Describe the process of harnessing solar energy and its applications in heating and cooling.
- Discuss fabrication, operation of solar cell, electrical characteristics, sizing and design of solar PV systems and their applications.
- Explain basic Principles of Wind Energy Conversion, collection of wind data, energy estimation and site selection.
- Discuss the performance of Wind-machines, energy storage, applications of Wind Energy and environmental aspects.

### Graduate Attributes (As per NBA)


### Question Paper Pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.
### Textbook

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Author</th>
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</tr>
</thead>
</table>

### Reference Books

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<tr>
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<th>Edition</th>
</tr>
</thead>
</table>
B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI

ARTIFICIAL NEURAL NETWORKS & FUZZY LOGIC (Open Elective)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>15EE661</th>
<th>IA Marks</th>
<th>IA Marks</th>
<th>Exam Hours</th>
<th>Exam Marks</th>
<th>Credits - 03</th>
</tr>
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<tbody>
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<td>40</td>
<td>80</td>
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</table>

Course objectives:
- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback networks.
- To teach about the concept of fuzziness involved in various systems.
- To provide adequate knowledge about fuzzy set theory.

Module-1

**Fundamentals of Neural Networks:** Basic concepts of Neural networks, Human Brain, Model of an Artificial Neuron, Neural network architectures, Characteristics of Neural Networks, Learning methods, Taxonomy of Neural Network Architectures, Early Neural Network Architectures.

**Back propagation Networks:** Architecture of a Back propagation network, the Perceptron Model, The solution, Single layer Artificial Neural Network, Model for Multilayer Perceptron, Back propagation Learning, Illustration, Applications.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

Module-2

**Back propagation Networks (continued):** Effect of Tuning Parameters of the Back propagation Neural Network, Selection of Various Parameters in BPN, Variations of Standard Back propagation Algorithm.

**Associative Memory:** Auto correlators, Hetero correlators: Kosko’s Discrete BAM, Wang et al.’s Multiple Training Encoding Strategy, Exponential BAM, Associative Memory for Real-coded Pattern Pairs, Applications, Recent Trends.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

Module-3

**Adaptive Resonance Theory:** Introduction, ART 1, ART 2, Applications, Sensitivities of Ordering of Data.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

Module-4

**Fuzzy Set Theory:** Fuzzy versus Crisp, Crisp sets, Fuzzy Sets, Crisp Relations, FuzzyRelations.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

Module-5

**Fuzzy Logic And Inference:** Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Rule based System, Defuzzification Methods, Applications.

**Type – 2 Fuzzy Sets:** Representation of Type – 2 Fuzzy Sets, Operations on Type – 2 Fuzzy Sets, Interval Type – 2 Fuzzy Sets.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.
Course outcomes:
At the end of the course the student will be able to:
- Show an understanding of Organization of the Brain, Biological and Artificial Neuron Models
- Show an understanding of Back propagation network architecture, Perceptron Model, Single layer Artificial Neural Network, Model for Multilayer Perceptron, Back propagation Learning.
- Show an understanding of Back propagation training and summary of Back propagation Algorithm
- Show an understanding Bidirectional Associative Memory (BAM) Architecture
- Show an understanding adaptive resonance theory architecture and its applications
- Differentiate between crisp logic, predicate logic and fuzzy logic.
- Explain fuzzy rule based system
- Show an understanding of Defuzzification methods.

Graduate Attributes (As per NBA)
Engineering Knowledge

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook

<table>
<thead>
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<th></th>
<th>Title</th>
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Reference Books

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<tr>
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<th>Title</th>
<th>Author</th>
<th>Publisher</th>
<th>Edition</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Neural Networks – A comprehensive foundation</td>
<td>Simon Haykin</td>
<td>Prentice Hall</td>
<td>3rd Edition, 2004</td>
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<tr>
<td>3</td>
<td>Fuzzy sets and Fuzzy Logic: Theory and Applications</td>
<td>Klir, G.J. Yuan Bo</td>
<td>Prentice Hall</td>
<td>2005</td>
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<td>Subject Code</td>
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<td>Exam Hours</td>
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<tr>
<td>Total Number of Lecture Hours</td>
<td>40</td>
<td>Exam Marks</td>
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</table>

**Credits – 03**

**Course objectives:**
- To discuss need of transducers, their classification, advantages and disadvantages.
- To discuss working of different types of transducers and sensors.
- To discuss recent trends in sensor technology and their selection.
- To discuss basics of signal conditioning and signal conditioning equipment.
- To discuss configuration of Data Acquisition System and data conversion.
- To discuss the basics of Data transmission and telemetry.
- To explain measurement of various non-electrical quantities.

**Module-1**

**Sensors and Transducers:** Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

**Module-2**


| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

**Module-3**

**Signal Condition:** Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

**Module-4**

**Data Acquisition Systems and Conversion:** Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

**Module-5**

**Data Transmission and Telemetry:** Data/Signal Transmission, Telemetry.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

**Module-5**


| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |
Course outcomes:
At the end of the course the student will be able to:
- Discuss need of transducers, their classification, advantages and disadvantages.
- Show an understanding of working of various transducers and sensors.
- Discuss recent trends in sensor technology and their selection.
- Discuss basics of signal conditioning and signal conditioning equipment.
- Discuss configuration of Data Acquisition System and data conversion.
- Show knowledge of data transmission and telemetry.
- Explain measurement of non-electrical quantities - temperature, flow, speed, force, torque, power and viscosity.

Graduate Attributes (As per NBA)
Engineering Knowledge

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook


Reference Books

| 2 | A Course in Electrical and Electronic Measurements and Instrumentation | A. K. Sawhney | Dhanpat Rai | 2015 |
### Course objectives:
- To discuss the current status of various rechargeable batteries and fuel cells for various applications.
- To discuss the performance capabilities and limitations of batteries and fuel cells.
- To discuss the performance requirements for next-generation high-power rechargeable lithium-based batteries and sealed nickel-cadmium and lead-acid batteries.
- To discuss fuel cells that are best suited for applications where electrical power requirements vary between several kilowatts (kW) to a few megawatts (MW).
- To describe the high-power batteries currently used by EVs and HEVs and various next-generation rechargeable batteries best suited for all-electric cars, EVs, and HEVs.
- To discuss fuel cells that are best suited for applications where electrical power requirements vary between several kilowatts (kW) to a few megawatts (MW).
- To discuss low-power battery configurations that are best suited for compact commercial, industrial, and medical applications.
- To identify the design aspects and performance characteristics of micro- and nano-batteries best suited for detection, sensing, and monitoring devices.

### Module-1
**Current Status of Rechargeable Batteries and Fuel Cells:**

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours</td>
<td>08</td>
</tr>
</tbody>
</table>

### Module-2
**Batteries for Aerospace and Communications Satellites:**

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours</td>
<td>08</td>
</tr>
</tbody>
</table>

### Module-3
**Fuel Cell Technology:**

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours</td>
<td>08</td>
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</tbody>
</table>

### Module-4
**Batteries for Electric and Hybrid Vehicles:**
Introduction, Chronological Development History of Early Electric Vehicles and Their Performance Parameters, Electric and Hybrid Electric Vehicles.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours</td>
<td>08</td>
</tr>
</tbody>
</table>
### Batteries for Electric and Hybrid Vehicles (continued):
Developed Earlier by Various Companies and Their Performance Specifications, Development History of the Latest Electric and Hybrid Electric Vehicle Types and Their Performance Capabilities and Limitations, Performance Requirements of Various Rechargeable Batteries, Materials for Rechargeable Batteries, Critical Role of Rare Earth Materials in the Development of EVs and HEVs.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Module-5

**Low-Power Rechargeable Batteries for Commercial, Space, and Medical Applications:**

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Course outcomes:
At the end of the course the student will be able to:
- Discuss the current status, the performance capabilities and limitations of rechargeable batteries and fuel cells for various applications.
- To discuss the performance requirements for next-generation high-power rechargeable lithium-based batteries and sealed nickel-cadmium and lead-acid batteries.
- Discuss fuel cells that are best suited for applications where electrical power requirements vary between several kilowatts (kW) to a few megawatts (MW)
- Describe the high-power batteries currently used by EVs and HEVs and various next-generation rechargeable batteries best suited for all-electric cars, EVs, and HEVs.
- Discuss low-power battery configurations that are best suited for compact commercial, industrial, and medical applications.
- Explain the design aspects and performance characteristics of micro- and nano-batteries best suited for detection, sensing, and monitoring devices.

### Graduate Attributes (As per NBA)
Engineering Knowledge

### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Textbook

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Next-Generation Batteries and Fuel Cells for Commercial, Military, and Space Applications</td>
<td></td>
<td></td>
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</table>

### Reference Books

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Course objectives:
- To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- To discuss system analogs and vectors, with a review of differential equations.
- To discuss the concept of transfer functions for the representation of differential equations.
- To discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- To represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- To determine the frequency response techniques for proper servo compensation.
- To explain performance indices and performance criteria for servo systems.
- To discuss the mechanical considerations of servo systems.

### Module-1


**Revised Bloom’s Taxonomy Level**: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

### Module-2

**Machine Servo Drives**: Types of Drives, Feed Drive Performance.

**Troubleshooting Techniques**: Techniques by Drive, Problems: Their Causes and Cures.

**Machine Feed Drives**: Advances in Technology, Parameters for making Application Choices.


**Revised Bloom’s Taxonomy Level**: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

### Module-3


**Indexes of Performance**: Definition of Indexes of Performance for Servo Drives, Indexes of Performance for Electric and Hydraulic Drives.

**Revised Bloom’s Taxonomy Level**: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

### Module-4

**Performance Criteria**: Percent Regulation, Servo System Responses.

**Servo Plant Compensation Techniques**: Dead-Zone Nonlinearity, Change-in-Gain Nonlinearity, Structural Resonances, Frequency Selective Feedback, Feedforward Control.

**Machine Considerations**: Machine feed drive Considerations, Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives.

**Revised Bloom’s Taxonomy Level**: L₁ – Remembering, L₂ – Understanding.
15EE664 INDUSTRIAL SERVO CONTROL SYSTEMS (Open Elective) (continued)

Module-5

<table>
<thead>
<tr>
<th>Machine Considerations: Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed Considerations, Drive Ratio Considerations, Drive Thrust/Torque And Friction Considerations, Drive Duty Cycles.</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>08</td>
<td></td>
</tr>
</tbody>
</table>

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

Course outcomes:
At the end of the course the student will be able to:
- Explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- Discuss system analogs and vectors, with a review of differential equations.
- Discuss the concept of transfer functions for the representation of differential equations.
- Discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- Represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- Determine the frequency response techniques for proper servo compensation.
- Explain perform indices and performance criteria for servo systems.
- Discuss the mechanical considerations of servo systems.

Graduate Attributes (As per NBA)
Engineering Knowledge

Question paper pattern:
- The question paper will have ten questions.
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Text Book

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>Industrial Servo Control Systems Fundamentals and Applications</td>
</tr>
<tr>
<td></td>
<td>George W. Younkin</td>
</tr>
</tbody>
</table>

Reference Books

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<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Servo Motors and Industrial Control Theory</td>
</tr>
<tr>
<td></td>
<td>Riazollah Firoozian</td>
</tr>
<tr>
<td>2</td>
<td>DC SERVOS Application and Design with MATLAB</td>
</tr>
<tr>
<td></td>
<td>Stephen M. Tobin</td>
</tr>
</tbody>
</table>
Control System Laboratory

Subject Code: 15EEL67
IA Marks: 20
Number of Practical Hours/Week: 03
Exam Hours: 03
Total Number of Practical Hours: 42
Exam Marks: 80
Credits: 02

Course objectives:
- To determine the time and frequency domain responses of a given second order system using software package or discrete components.
- To design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
- To draw the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair.
- To simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
- To write a script files to plot root locus, bode plot, Nyquist plots to study the stability of the system using a software package.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor</td>
</tr>
<tr>
<td>2</td>
<td>Experiment to draw synchro pair characteristics</td>
</tr>
<tr>
<td>3</td>
<td>Experiment to determine frequency response of a second order system</td>
</tr>
</tbody>
</table>
| 4      | (a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response.  
(b) To determine experimentally the transfer function of the lead compensating network. |
| 5      | (a) To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response.  
(b) To determine experimentally the transfer function of the lag compensating network |
| 6      | Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function. |
| 7      | (a) To simulate a typical second order system and determine step response and evaluate time response specifications.  
(b) To evaluate the effect of additional poles and zeros on time response of second order system.  
(c) To evaluate the effect of pole location on stability  
(d) To evaluate the effect of loop gain of a negative feedback system on stability. |
| 8      | To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response. |
| 9      | (a) To simulate a D.C. Position control system and obtain its step response.  
(b) To verify the effect of input waveform, loop gain and system type on steady state errors.  
(c) To perform trade-off study for lead compensator.  
(d) To design PI controller and study its effect on steady state error. |
| 10     | (a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response  
(b) To study the effect of open loop gain on transient response of closed loop system using root locus. |
| 11     | (a) To study the effect of open loop poles and zeros on root locus contour  
(b) To estimate the effect of open loop gain on the transient response of closed loop system using root locus.  
(c) Comparative study of Bode, Nyquist and root locus with respect to stability. |

### Course outcomes:
At the end of the course the student will be able to:

- Use software package or discrete components in assessing the time and frequency domain responses of a given second order system.
- Design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
- Determine the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair used in control systems.
- Simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
- Write a script files to plot root locus, bode plot, Nyquist plots to study the stability of the system using a software package.
- Work with a small team to carryout experiments and prepare reports that present lab work.

### Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Modern tool usage, Communication.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
#### CHOICE BASED CREDIT SYSTEM (CBCS)  
#### SEMESTER - VI

#### DIGITAL SIGNAL PROCESSING LABORATORY

<table>
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<th>Subject Code</th>
<th>15EEL68</th>
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<tr>
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<td>03</td>
<td>Exam Hours</td>
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<tr>
<td>Total Number of Practical Hours</td>
<td>42</td>
<td>Exam Marks</td>
<td>80</td>
</tr>
</tbody>
</table>

**Credits - 02**

### Course objectives:
- To explain the use of MATLAB software in evaluating the DFT and IDFT of given sequence.
- To verify the convolution property of the DFT.
- To design and implementation of IIR and FIR filters for given frequency specifications.
- To realize IIR and FIR filters.
- To help the students in developing software skills.

### Sl. No | Experiments
--- | ---
1 | Verification of Sampling Theorem both in time and frequency domains
2 | Evaluation of impulse response of a system
3 | To perform linear convolution of given sequences
4 | To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.
5 | Computation of N – point DFT and to plot the magnitude and phase spectrum.
6 | Linear and circular convolution by DFT and IDFT method.
7 | Solution of a given difference equation.
8 | Calculation of DFT and IDFT by FFT.
9 | Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)
10 | Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions.
11 | Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.
12 | Realization of IIR and FIR filters.

### Revised Bloom’s Taxonomy Level

| L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing, L₅ – Evaluating |

### Course outcomes: At the end of the course the student will be able to:
- Give physical interpretation of sampling theorem in time and frequency domains.
- Evaluate the impulse response of a system.
- Perform convolution of given sequences to evaluate the response of a system.
- Compute DFT and IDFT of a given sequence using the basic definition and/or fast methods.
- Provide a solution for a given difference equation.
- Design and implement IIR and FIR filters.
- Conduct experiments using software and prepare reports that present lab work.

### Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

### Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**** END ****
VII SEMESTER DETAILED SYLLABUS
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - VII

POWER SYSTEM ANALYSIS – 2 (Core Course)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE71</td>
<td>20</td>
<td>80</td>
</tr>
</tbody>
</table>

Number of Lecture Hours/Week | 04 | Exam Hours | 03
Total Number of Lecture Hours | 50

Credits - 04

Course objectives:
- To explain formulation of network models and bus admittance matrix for solving load flow problems.
- To discuss solution of nonlinear static load flow equations by different numerical techniques and methods to control voltage profile.
- To discuss optimal operation of generators on a bus bar, optimal unit commitment, reliability considerations and optimum generation scheduling.
- To discuss optimal power flow solution, scheduling of hydro-thermal system, power system security and reliability.
- To explain formulation of bus impedance matrix for the use in short circuit studies on power systems.
- To explain numerical solution of swing equation for multi-machine stability.

Module-1

**Load Flow Studies:** Introduction, Network Model Formulation, Formation of $Y_{bus}$ by Singular Transformation, Load Flow Problem, Gauss-Seidel Method.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying L₄ – Analysing.

Module-2

**Load Flow Studies (continued):** Newton-Raphson Method, Decoupled Load Flow Methods, Comparison of Load Flow Methods, Control of Voltage Profile.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying L₄ – Analysing.

Module-3

**Optimal System Operation:** Introduction, Optimal Operation of Generators on a Bus Bar, Optimal Unit Commitment, Reliability Considerations, Optimum Generation Scheduling.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying L₄ – Analysing.

Module-4


Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying L₄ – Analysing.

Module-5

**Symmetrical Fault Analysis:** Algorithm for Short Circuit Studies, $Z_{bus}$ Formulation.

**Power System Stability:** Numerical Solution of Swing Equation, Multimachine Stability.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying L₄ – Analysing.

Course outcomes:
At the end of the course the student will be able to:
- Formulate network matrices and models for solving load flow problems.
- Perform steady state power flow analysis of power systems using numerical iterative techniques.
- Suggest a method to control voltage profile.
- Show knowledge of optimal operation of generators on a bus bar, optimal unit commitment,
## B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
15EE71 POWER SYSTEM ANALYSIS – 2 (Core Subject) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

### Course outcomes (continued):

- Discuss optimal scheduling for hydro-thermal system, power system security and reliability.
- Analyze short circuit faults in power system networks using bus impedance matrix.
- Perform numerical solution of swing equation for multi-machine stability.

### Graduate Attributes (As per NBA)


### Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

### Textbook

|---|--------------------------------|---------------|-------------|-------------------|

### Reference Books

|---|--------------------------------------------|----------------------------------|-------------|-------------------|
### Course objectives:
- To discuss performance of protective relays, components of protection scheme and relay terminology.
- To explain relay construction and operating principles.
- To explain Overcurrent protection using electromagnetic and static relays and Overcurrent protective schemes.
- To discuss types of electromagnetic and static distance relays, effect of arc resistance, power swings, line length and source impedance on performance of distance relays.
- To discuss pilot protection; wire pilot relaying and carrier pilot relaying.
- To discuss construction, operating principles and performance of various differential relays for differential protection.
- To discuss protection of generators, motors, Transformer and Bus Zone Protection.
- To explain the principle of circuit interruption and different types of circuit breakers.
- To describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.
- To discuss protection Against Overvoltages and Gas Insulated Substation (GIS).

### Module 1


**Relay Construction and Operating Principles:** Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.


- **Revised Bloom’s Taxonomy Level:** L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

### Module 2


**Distance Protection:** Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays.

- **Revised Bloom’s Taxonomy Level:** L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

### Module 3


**Rotating Machines Protection:** Introduction, Protection of Generators.

**Transformer and Buszone Protection:** Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection.

- **Revised Bloom’s Taxonomy Level:** L₂ – Understanding, L₃ – Applying, L₄ – Analysing, L₅ – Evaluating.
## Module 4


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching Hours</strong></td>
<td>10</td>
</tr>
</tbody>
</table>

## Module 5

**Fuses**: Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination.

**Protection against Overvoltages**: Causes of Overvoltages, Lightning phenomena, Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning, Klydonograph and Magnetic Link, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub – Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL).


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching Hours</strong></td>
<td>10</td>
</tr>
</tbody>
</table>

## Course outcomes:

At the end of the course the student will be able to:

- Discuss performance of protective relays, components of protection scheme and relay terminology overcurrent protection.
- Explain the working of distance relays and the effects of arc resistance, power swings, line length and source impedance on performance of distance relays.
- Discuss pilot protection; wire pilot relaying and carrier pilot relaying.
- Discuss construction, operating principles and performance of differential relays for differential protection.
- Discuss protection of generators, motors, Transformer and Bus Zone Protection.
- Explain the principle of circuit interruption in different types of circuit breakers.
- Describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.
- Discuss protection against Overvoltages and Gas Insulated Substation (GIS).

## Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Ethics, Communication, Lifelong Learning.

## Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

## Textbook

<table>
<thead>
<tr>
<th></th>
<th>Power System Protection and Switchgear</th>
<th>Badri Ram, D.N. Vishwakarma</th>
<th>McGraw Hill</th>
<th>2nd Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Power System Protection and Switchgear (For additional study on gapless arrester, Refer to pages 458 to 461)</td>
<td>Bhuvanesh Oza et al</td>
<td>McGraw Hill</td>
<td>1st Edition, 2010</td>
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<tr>
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</tr>
<tr>
<td>Subject Code</td>
<td>15EE73</td>
<td>IA Marks</td>
<td>20</td>
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<tr>
<td>-------------------</td>
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<td></td>
</tr>
<tr>
<td>Number of Lecture Hours/Week</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
<td></td>
</tr>
<tr>
<td>Total Number of Lecture Hours</td>
<td>50</td>
<td>Exam Marks</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

**Course objectives:**
- To discuss conduction and breakdown in gases, liquid dielectrics.
- To discuss breakdown in solid dielectrics.
- To discuss generation of high voltages and currents and their measurement.
- To discuss overvoltage phenomenon and insulation coordination in electric power systems.
- To discuss non-destructive testing of materials and electric apparatus.
- To discuss high-voltage testing of electric apparatus.

<table>
<thead>
<tr>
<th>Module-1</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conduction and Breakdown in Gases:</strong></td>
<td>Gases as Insulating Media, Collision Process, Ionization Processes, Townsend’s Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend’s Criterion for Breakdown, Experimental Determination of Coefficients α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen’s Law, Breakdown in Non-Uniform Fields and Corona Discharges.</td>
</tr>
<tr>
<td><strong>Conduction and Breakdown in Liquid Dielectrics:</strong></td>
<td>Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids.</td>
</tr>
<tr>
<td><strong>Breakdown in Solid Dielectrics:</strong></td>
<td>Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.</td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**
- L₁ – Remembering, L₂ – Understanding.

<table>
<thead>
<tr>
<th>Module-2</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generation of High Voltages and Currents:</strong></td>
<td>Generation of High Direct Current Voltages, Generation of High Alternating Voltages, Generation of Impulse Voltages, Generation of Impulse Currents, Tripping and Control of Impulse Generators.</td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**

<table>
<thead>
<tr>
<th>Module-3</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement of High Voltages and Currents:</strong></td>
<td>Measurement of High Direct Current Voltages, Measurement of High AC and Impulse Voltages, Measurement of High Currents – Direct, Alternating and Impulse, Cathode Ray Oscillographs for Impulse Voltage and Current Measurements.</td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**

<table>
<thead>
<tr>
<th>Module-4</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems:</strong></td>
<td>National Causes for Overvoltages - Lightning Phenomenon, Overvoltage due to Switching Surges, System Faults and Other Abnormal, Principles of Insulation Coordination on High Voltage and Extra High Voltage Power Systems.</td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**
- L₁ – Remembering, L₂ – Understanding.

<table>
<thead>
<tr>
<th>Module-5</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Destructive Testing of Materials and Electrical Apparatus:</strong></td>
<td>Introduction, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements.</td>
</tr>
</tbody>
</table>
Module-5 (continued)


| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

Course outcomes:
At the end of the course the student will be able to:
- Explain conduction and breakdown phenomenon in gases, liquid dielectrics.
- Explain breakdown phenomenon in solid dielectrics.
- Explain generation of high voltages and currents.
- Discuss measurement techniques for high voltages and currents.
- Discuss overvoltage phenomenon and insulation coordination in electric power systems.
- Discuss non-destructive testing of materials and electric apparatus and high-voltage testing of electric apparatus.

Graduate Attributes (As per NBA)

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>High-Voltage Test and Measuring Techniques</td>
<td>Wolfgang Hauschild • Eberhard Lemke</td>
<td>Springer</td>
<td>1st Edition 2014</td>
</tr>
</tbody>
</table>
# Advanced Control Systems

**Course Code:** 15EE741  
**IA Marks:** 20  
**Number of Lecture Hours/Week:** 03  
**Exam Hours:** 03  
**Total Number of Lecture Hours:** 40  
**Exam Marks:** 80  
**Credits:** 03

## Course Objectives:
- To introduce state variable approach for linear time invariant systems in both the continuous and discrete time systems.
- To explain development of state models for linear continuous – time and discrete – time systems.
- To explain application of vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.
- To define controllability and observability of a system and testing techniques for controllability and observability of a given system.
- To explain design techniques of pole assignment and state observer using state feedback.
- To explain about inherent and intentional nonlinearities that can occur in control system and developing the describing function for the nonlinearities.
- To explain stability analysis of nonlinear systems using describing function analysis.
- To explain the analysis of nonlinear systems using Lyapunov function and design of Lyapunov function for stable systems.

### Module-1

**State Variable Analysis and Design:** Introduction, Concept of State, State Variables and State Model, State Models for Linear Continuous – Time Systems, State Variables and Linear Discrete – Time Systems.

**Revised Bloom’s Taxonomy Level:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating.

### Module-2

**State Variable Analysis and Design (continued):** Diagonalization, Solution of State Equations, Concepts of Controllability and Observability.

**Revised Bloom’s Taxonomy Level:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating.

### Module-3


**Revised Bloom’s Taxonomy Level:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating.

### Module-4


**Revised Bloom’s Taxonomy Level:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating.

### Module-5


**Revised Bloom’s Taxonomy Level:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating.
Course outcomes:
At the end of the course the student will be able to:

- Discuss state variable approach for linear time invariant systems in both the continuous and discrete time systems.
- Develop state models for linear continuous – time and discrete – time systems.
- Apply vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.
- Define controllability and observability of a system and test for controllability and observability of a given system.
- Design pole assignment and state observer using state feedback.
- Develop the describing function for the nonlinearity present to assess the stability of the system.
- Develop Lyapunov function for the stability analysis of nonlinear systems.

Graduate Attributes (As per NBA)

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Textbook

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(For the Modules 1 and 2)</td>
<td></td>
<td></td>
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</tbody>
</table>
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

#### UTILIZATION OF ELECTRICAL POWER(Professional Elective)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Hours</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE742</td>
<td>20</td>
<td>03</td>
<td>40</td>
<td>80</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course objectives:**
- To discuss electric heating, air-conditioning and electric welding.
- To explain laws of electrolysis, extraction and refining of metals and electro deposition.
- To explain the terminology of illumination, laws of illumination, construction and working of electric lamps.
- To explain design of interior and exterior lighting systems- illumination levels for various purposes light fittings- factory lighting- flood lighting-street lighting
- To discuss systems of electric traction, speed time curves and mechanics of train movement.
- To discuss motors used for electric traction and their control.
- To discuss braking of electric motors, traction systems and power supply and other traction systems.
- Give awareness of technology of electric and hybrid electric vehicles.

<table>
<thead>
<tr>
<th>Module</th>
<th>Teaching Hours</th>
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</table>

<table>
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<tr>
<th>Module</th>
<th>Teaching Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Module</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motors for Electric traction: Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors (Series Type) are used to drive a Motor Car, Tractive Effort and Horse Power, AC Series Motor, Three Phase Induction Motor.</td>
<td></td>
</tr>
<tr>
<td>Control of motors: Control of DC Motors, Tapped Field Control or Control by Field Weakening, Multiple Unit Control, Control of Single Phase Motors, Control of Three Phase Motors.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes.</td>
<td>08</td>
</tr>
</tbody>
</table>
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - VII  
15EE742 UTILIZATION OF ELECTRICAL POWER (Professional Elective) (continued)

<table>
<thead>
<tr>
<th>Module-4 (continued)</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traction, Feeding and Distribution System for DC Tramways, Electrolysis by Currents through Earth, Negative Booster, System of Current Collection, Trolley Wires.</td>
<td></td>
</tr>
</tbody>
</table>

Revised Bloom's Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

<table>
<thead>
<tr>
<th>Module-5</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Vehicles: Configurations of Electric Vehicles, Performance of Electric Vehicles, Ttractive Effort in Normal Driving, Energy Consumption. **</td>
<td>08</td>
</tr>
<tr>
<td>Hybrid Electric Vehicles: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains.</td>
<td></td>
</tr>
</tbody>
</table>

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

**Course outcomes:**  
At the end of the course the student will be able to:  
- Discuss electric heating, air-conditioning and electric welding.  
- Explain laws of electrolysis, extraction and refining of metals and electro deposition.  
- Explain the terminology of illumination, laws of illumination, construction and working of electric lamps.  
- Design interior and exterior lighting systems- illumination levels for factory lighting- flood lighting-street lighting.  
- Discuss systems of electric traction, speed time curves and mechanics of train movement.  
- Explain the motors used for electric traction and their control.  
- Discuss braking of electric motors, traction systems and power supply and other traction systems.  
- Explain the working of electric and hybrid electric vehicles.  

**Graduate Attributes (As per NBA)**  
Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, The Engineer and Society, Ethics, Individual and Team Work.

**Question paper pattern:**  
- The question paper will have ten questions.  
- Each full question is for 16 marks.  
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.  
- Each full question with sub questions will cover the contents under a module.  
- Students will have to answer 5 full questions, selecting one full question from each module.

**Textbook**  
1. A Textbook on Power System Engineering  
   A. Chakrabarti et al  
   Dhanpat Rai and Co  
   2nd Edition, 2010

2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design (Chapters 04 and 05 for module 5)  
   Mehrdad Ehsani et al  
   CRC Press  
   1st Edition, 2005

**Reference Books**  
1. Utilization, Generation and Conservation of Electrical Energy  
   Sunil S Rao  
   Khanna Publishers  

2. Utilization of Electric Power and Electric Traction  
   G.C. Garg  
   Khanna Publishers  
### Course Objectives:
- To provide an overview of carbon capture and carbon storage and explain the fundamentals of power generation.
- To explain carbon capture from power generation, industrial processes, using solvent absorption and other technologies including membranes, adsorbents, chemical looping, cryogenics and gas hydrate technology.
- To explain different geological storage methods including storage in coal seams, depleted gas reservoirs and saline formations.
- To explain Carbon dioxide compression and pipeline transport.

### Module-1


**Overview of carbon capture and storage:** Carbon Capture, Carbon Storage.


**Revised Bloom’s Taxonomy Level**  
L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

### Module-2

**Carbon capture from power generation:** Introduction, Pre-combustion Capture, Post-combustion Capture, Oxy-fuel Combustion Capture, Chemical Looping Capture Systems, Capture-Ready and Retrofit Power Plant, Approaches to Zero-Emission Power Generation.

**Carbon capture from industrial processes:** Cement Production, Steel Production, Oil Refining, Natural Gas Processing.

**Absorption capture systems:** Chemical and Physical Fundamentals, Absorption Applications in Post Combustion Capture, Absorption Technology RD&D Status.

**Revised Bloom’s Taxonomy Level**  

### Module-3

**Adsorption capture systems:** Physical and Chemical Fundamentals, Adsorption Process Applications, Adsorption Technology RD&D Status. References and Resources.

**Membrane separation systems:** Physical and Chemical Fundamentals, Membrane Configuration and Preparation and Module Construction, Membrane Technology RD&D Status, Membrane Applications in Pre-combustion Capture, Membrane and Molecular Sieve Applications in Oxy-fuel Combustion, Membrane Applications in Post-combustion CO₂ Separation, Membrane Applications in Natural Gas Processing.

**Revised Bloom’s Taxonomy Level**  

### Module-4

**Cryogenic and distillation systems:** Physical Fundamentals, Distillation column configuration and operation, Cryogenic oxygen production for oxy-fuel combustion, Ryan–Holmes process for CO₂ – CH₄ separation, RD&D in cryogenic and distillation technologies.

**Mineral carbonation:** Physical and chemical fundamentals, Current state of technology development. Demonstration and deployment outlook.

**Geological storage:** Introduction, Geothermal and engineering fundamentals, Enhanced oil recovery, Saline aquifer storage, Other geological storage options.

**Revised Bloom’s Taxonomy Level**  
L₁ – Remembering, L₂ – Understanding.
## Module-5

| Ocean storage: Introduction, Physical, chemical, and biological fundamentals, Direct CO$_2$ injection, Chemical sequestration, Biological sequestration, |
| Storage in terrestrial ecosystems: Introduction, Biological and chemical fundamentals, Terrestrial carbon storage options, Full GHG accounting for terrestrial storage, Current R&D focus in terrestrial storage, |
| Other sequestration and use options: Enhanced industrial usage, Algal biofuel production. |

### Teaching Hours

| Module-5 | 08 |

### Revised Bloom’s Taxonomy Level

| L$_1$ – Remembering, L$_2$ – Understanding. |

### Course outcomes:

At the end of the course the student will be able to:

- Discuss the impacts of climate change and the measures that can be taken to reduce emissions.
- Discuss carbon capture and carbon storage.
- Explain the fundamentals of power generation.
- Explain methods of carbon capture from power generation and industrial processes.
- Explain different carbon storage methods: storage in coal seams, depleted gas reservoirs and saline formations.
- Explain Carbon dioxide compression and pipeline transport.

### Graduate Attributes (As per NBA)

**Engineering Knowledge**

### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Textbook

| 1 | Carbon Capture and Storage | Stephen A. Rackley | Elsevier | 2010 |
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

POWER SYSTEM PLANNING (Professional Elective)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Hours</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Marks</th>
<th>Credits</th>
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<tr>
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<td>03</td>
<td>03</td>
<td>40</td>
<td>8</td>
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Course objectives:
- To discuss primary components of power system planning namely load furcating, evaluation of energy resources, provisions of electricity Act and Energy Conservation Act.
- To explain planning methodology for optimum power system expansion, various types of generation, transmission and distribution.
- To explain forecasting of anticipated future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
- To discuss methods to mobilize resources to meet the investment requirement for the power sector.
- To perform economic appraisal to allocate the resources efficiently and take proper investment decisions.
- To discuss expansion of power generation and planning for system energy in the country.
- To discuss evaluation of operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions.
- To discuss principles of distribution planning, supply rules, network development and the system studies.
- To discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis.
- To discuss grid reliability, voltage disturbances and their remedies.
- To discuss planning and implementation of electric –utility activities designed to influence consumer uses of electricity.
- To discuss market principles and the norms framed by CERC for online trading and exchange in the interstate power market.

Module-1


**Electricity Forecasting:** Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.

Revised Bloom’s Taxonomy Level L₁ – Remembering, L₂ – Understanding.

Module-2


Revised Bloom’s Taxonomy Level L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

Module-3

**Generation Expansion (continued):** Distributed Power Generation, Renovation and Modernisation of Power Plants.


Revised Bloom’s Taxonomy Level L₁ – Remembering, L₂ – Understanding.

Module-4


<table>
<thead>
<tr>
<th>Teaching Hours</th>
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<tbody>
<tr>
<td>Module-4 (continued)</td>
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<td>----------------------</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-5</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding.</td>
</tr>
</tbody>
</table>

## Course outcomes:
At the end of the course the student will be able to:
- Discuss primary components of power system planning, planning methodology for optimum power system expansion, various types of generation, transmission and distribution.
- Show knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
- Discuss methods to mobilize resources to meet the investment requirement for the power sector.
- Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions.
- Discuss expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.
- Discuss principles of distribution planning, supply rules, network development and the system studies.
- Discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis, grid reliability, voltage disturbances and their remedies.
- Discuss planning and implementation of electric utility activities, market principles and the norms framed by CERC for online trading and exchange in the interstate power market.

## Graduate Attributes (As per NBA)

## Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

## Textbook
Course objectives:

- To discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- To explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- To describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- To describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- To explain advantages of HVDC power transmission, overview and organization of HVDC system.
- To describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions.

### Module-1

#### FACTS Concept and General System Considerations:

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

### Module-2

#### Static Shunt Compensators:

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Module-3

#### Static Series Compensators:

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Module-4

#### Development of HVDC Technology:

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

#### Power Conversion:
3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter.
## Module-5

### Control of HVDC Converter and System:
- Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding.</th>
</tr>
</thead>
</table>

### Course outcomes:
At the end of the course the student will be able to:

- Discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- Explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- Describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- Describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- Explain advantages of HVDC power transmission, overview and organization of HVDC system.
- Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions.

### Graduate Attributes (As per NBA)

### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Textbooks

<table>
<thead>
<tr>
<th>Textbook</th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
</table>

### Reference Books

<table>
<thead>
<tr>
<th>Reference Book</th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
</table>
B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII

TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS(Professional Elective)

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>15EE752</td>
<td>I.A Marks</td>
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<tr>
<td>Number of Lecture Hours/Week</td>
<td>Exam Hours</td>
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</tr>
<tr>
<td>Total Number of Lecture Hours</td>
<td>Exam Marks</td>
<td>80</td>
</tr>
</tbody>
</table>

Course objectives:
- Describe the process to plan, control and implement commissioning of electrical equipment’s.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Identification of tools and equipment’s used for installation and maintenance of electrical equipment.
- Explain the operation of an electrical equipment’s such as isolators, circuit breakers, insulators and switchgears.

Module-1


Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding.

Module-2


Revised Bloom’s Taxonomy Level
L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

Module-3


Revised Bloom’s Taxonomy Level

Module-4

Laying of Underground Cables: Inspection, Storage, Transportation and Handling of Cables, Cable Handling Equipment, Cable Laying Depths and Clearances from other Services such as Water Sewerage, Gas, Heating and other Mains, Series of Power and Telecommunication Cables and Coordination with these Services, Excavation of Trenches, Cable Jointing and Terminations Testing and Commissioning. Location of Faults using Megger, Effect of Open or Loose Neutral Connections, Provision of Proper Fuses on Service Lines and Their Effect on System, Causes and Dini, and Flickering Lights.

Revised Bloom’s Taxonomy Level
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE752 TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS
(Professional Elective) (continued)

<table>
<thead>
<tr>
<th>Module-5</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switchgear and Protective Devices:</strong> Standards, Types, Specification, Installation, Commissioning Tests, Maintenance Schedule, Type and Routine Tests.</td>
<td>08</td>
</tr>
<tr>
<td><strong>Domestic Installation:</strong> Introduction, Testing of Electrical Installation of a Building, Testing of Insulation Resistance to Earth, Testing of Insulation and Resistance between Conductors Continuity or Open Circuit Test, Short Circuit Test, Testing of Earthing Continuity, Location of Faults, IE Rules for Domestic Installation.</td>
<td></td>
</tr>
</tbody>
</table>

**Revised Bloom’s Taxonomy Level**


**Course outcomes:**
At the end of the course the student will be able to:
- Describe the process to plan, control and implement commissioning of electrical equipment’s.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Describe corrective and preventive maintenance of electrical equipment’s.
- Explain the operation of an electrical equipment’s such as isolators, circuit breakers, induction motor and synchronous machines.

**Graduate Attributes (As per NBA)**

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text/ Reference Books**

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Author</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
</table>
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - VII  
SPACECRAFT POWER TECHNOLOGIES (Professional Elective)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Hours</th>
<th>Exam Marks</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>15EE753</td>
<td>20</td>
<td>03</td>
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</tbody>
</table>

Course objectives:
- To discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.
- To discuss near-earth environmental factors that will affect the design of space craft power systems.
- To describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.
- To discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.
- To discusses, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.
- To describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations.

Module-1

**Spacecraft:** Introduction, the Beginnings, the Electrical Power System.  
**Environmental Factors:** Introduction, Orbital Considerations, The Near-earth Space Environment.  
Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

Module-2

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

Module-3

**Solar Energy Conversion (continued):** Space Solar Cell Arrays, Space Thermo photovoltaic Power Systems.  
Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

Module-4

**Chemical Storage and Generation Systems (continued):** Electrochemical Cell Types, Fuel Cell Systems.  
Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

Module-5

**Power Management and Distribution (PMAD):** Introduction, Functions of PMAD, Components and Packaging, System Examples.  
Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

Course outcomes:
At the end of the course the student will be able to:
- Discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.
- Discuss near-earth environmental factors that will affect the design of space craft power systems.
### Course outcomes (continued):
- Describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.
- Discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.
- Discusses, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.
- Describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations.

### Graduate Attributes (As per NBA)

### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Textbook
<table>
<thead>
<tr>
<th></th>
<th>Spacecraft Power Technologies</th>
<th>A.K. Hyder et al</th>
<th>Imperial College Press</th>
<th>1\textsuperscript{st} Edition, 2000</th>
</tr>
</thead>
</table>

### Reference Books
|  | Spacecraft Power Systems | Mukund R. Patel | CRC Press | 1\textsuperscript{st} Edition, 2004 |
### Course Objectives:
- To explain construction, classification of industrial furnaces and the methods of heat transfer in them.
- To discuss heating capacity of batch furnaces.
- To discuss heating capacity of continuous furnaces.
- To discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.
- To explain operation and control of industrial furnaces.

### Module-1
**Industrial Heating Processes:** Industrial Process Heating Furnaces, Classifications of Furnaces, Elements of Furnace Construction.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying. |

### Module-2
**Heating Capacity of Batch Furnaces:** Definition of Heating Capacity, Effect of Rate of Heat Liberation, Effect of Rate of Heat Absorption by the Load, Effect of Load Arrangement, Effect of Load Thickness, Vertical Heating, Batch Indirect-Fired Furnaces, Batch Furnace Heating Capacity Practice, Controlled Cooling in or After Batch Furnaces.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Module-3
**Heating Capacity of Continuous Furnaces:** Continuous Furnaces Compared to Batch Furnaces, Continuous Dryers, Ovens, and Furnaces for <1400 F (<760 C), Continuous Midrange Furnaces, 1200 to 1800 F (650 to 980 C), Sintering and Pelletizing Furnaces, Axial Continuous Furnaces for Above 2000 F (1260 C), Continuous Furnaces for 1900 to 2500 F (1038 to 1370 C), Continuous Liquid Heating Furnaces.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Module-4

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing. |

### Module-5
**Operation and Control of Industrial Furnaces:** Burner and Flame Types, Location, Flame Fitting, Unwanted NOₓ Formation, Controls and Sensors- Care, Location, Zones, Air/Fuel Ratio Control, Furnace Pressure Control Turndown Ratio, Furnace Control Data Needs, Soaking Pit Heating Control, Uniformity Control in Forge Furnaces, Continuous Reheat Furnace Control.

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding, L₃ – Applying. |
Course outcomes:
At the end of the course the student will be able to:
- Explain construction, classification of industrial furnaces.
- Discuss the methods of heat transfer in industrial furnaces.
- Discuss heating capacity of batch furnaces and continuous furnaces.
- Discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.
- Explain operation and control of industrial furnaces.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Design/Development of Solutions, Conduct investigations of complex problems.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook
|---|---------------------|-----------|-------|-------------------|
Course objectives:

- To explain the use of MATLAB package to assess the performance of medium and long transmission lines.
- To explain the use of MATLAB package to obtain the power angle characteristics of salient and non-salient pole alternator.
- To explain the use of MATLAB package to study transient stability of radial power systems under three phase fault conditions.
- To explain the use of MATLAB package to develop admittance and impedance matrices of interconnected power systems.
- To explain the use of MATLAB package to study optimal generation scheduling problems for thermal power plants.

Course outcomes:

At the end of the course the student will be able to:

- Develop a program in MATLAB to assess the performance of medium and long transmission lines.
- Develop a program in MATLAB to obtain the power angle characteristics of salient and non-salient pole alternator.
- Develop a program in MATLAB to assess the transient stability under three phase fault at different locations in a radial power systems.
- Develop programs in MATLAB to formulate bus admittance and bus impedance matrices of interconnected power systems.
- Use Mi-Power package to solve power flow problem for simple power systems.
- Use Mi-Power package to study unsymmetrical faults at different locations in radial power systems.
- Use of Mi-Power package to study optimal generation scheduling problems for thermal power plants.
Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■
Course objectives:
- To conduct experiments to verify the characteristics of over current, over voltage, under voltage relays both electromagnetic and static type.
- To verify the operation of negative sequence relay.
- To conduct experiments to verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.
- To conduct experiments on generator, motor and feeder protection.
- To conduct experiments to study the sparkover characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
- To measure high AC and DC voltages
- To experimentally measure the breakdown strength of transformer oil.
- To experimentally measure the capacitance of different electrode configuration models using Electrolytic Tank. To generate standard lightning impulse voltage and determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation.

Sl. NO | Experiments
---|---
1 | Part - A Over Current Relay: (a)Inverse Definite Minimum Time(IDMT)Non-Directional Characteristics (b) Directional Features (c) IDMT Directional.
2 | Part - B IDMT Characteristics of Over Voltage or Under Voltage Relay (Solid State or Electromechanical type).
3 | Operation of Negative Sequence Relay.
4 | Part - C Operating Characteristics of Microprocessor Based (Numeric) Over –Current Relay.
5 | Operating Characteristics of Microprocessor Based (Numeric) Distance Relay.
6 | Operating Characteristics of Microprocessor Based (Numeric) Over/Under Voltage Relay.
7 | Generation Protection: Merz Price Scheme.
8 | Feeder Protection against Faults.
9 | Motor Protection against Faults.
11 | Spark Over Characteristics of Air subjected to High voltage DC.
12 | Measurement of HVAC and HVDC using Standard Spheres as per IS 1876 :2005
13 | Measurement of Breakdown Strength of Transformer Oil as per IS 1876 :2005
14 | Field Mapping using Electrolytic Tank for any one of the following Models: Cable/ Capacitor/ Transmission Line/ Sphere Gap.
15 | (a) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator. (b) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage.

Revised Bloom’s Taxonomy Level: L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating
Course outcomes:
At the end of the course the student will be able to:
- Experimentally verify the characteristics of over current, over voltage, under voltage and negative sequence relays both electromagnetic and static type.
- Experimentally verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.
- Show knowledge of protecting generator, motor and feeders.
- Analyze the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
- Measure high AC and DC voltages and breakdown strength of transformer oil.
- **Draw electric field and** measure the capacitance of different electrode configuration models.
- Show knowledge of generating standard lightning impulse voltage to determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
### B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
### CHOICE BASED CREDIT SYSTEM (CBCS)
### SEMESTER - VII

#### PROJECT PHASE – I AND SEMINAR

<table>
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<td>Total Number of Practical Hours</td>
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</tbody>
</table>

**Credits - 02**

**Course objectives:**
- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

**Project Phase-I** Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

**Seminar:** Each student, under the guidance of a Faculty, is required to
- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

**Revised Bloom’s Taxonomy Level**

**Course outcomes:**
At the end of the course the student will be able to:
- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

**Graduate Attributes (As per NBA)**
- Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

**Continuous Internal Evaluation**
CIE marks for the project report (50 marks) and seminar (50 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman.
VIII SEMESTER DETAILED SYLLABUS
### Course Objectives:
- To describe various levels of controls in power systems and the vulnerability of the system.
- To explain components, architecture and configuration of SCADA.
- To define unit commitment and explain various constraints in unit commitment and the solution methods.
- To explain issues of hydrothermal scheduling and solutions to hydro thermal problems.
- To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control.
- To explain automatic generation control, voltage and reactive power control in an interconnected power system.
- To explain reliability and contingency analysis, state estimation and related issues.

### Module-1


**Supervisory Control and Data acquisition (SCADA)**: Introduction to SCADA and its Components, Standard SCADA Configurations, Users of Power Systems SCADA, Remote Terminal Unit for Power System SCADA, Common Communication Channels for SCADA in Power Systems, Challenges for Implementation of SCADA.

**Unit Commitment**: Introduction, Simple Enumeration Constraints, Priority List Method, Dynamic Programming Method for Unit Commitment.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L₁ – Remembering, L₂ – Understanding, L₄ – Analysing.</td>
<td></td>
</tr>
</tbody>
</table>

### Module-2

**Hydro-thermal Scheduling**: Introduction, Scheduling Hydro Systems, Discrete Time Interval Method, Short Term Hydro Thermal Scheduling Using \( \gamma - \lambda \) Iterations, Short Term Hydro Thermal Scheduling Using Penalty Factors.

**Automatic Generation Control (AGC)**: Introductions, Basic Generator Control Loops, Commonly used Terms in AGC, Functions of AGC, Speed Governors.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
<td></td>
</tr>
</tbody>
</table>

### Module-3

**Automatic Generation Control (continued)**: Mathematical Model of Automatic Load Frequency Control, AGC Controller, Proportional Integral Controller.

**Automatic Generation Control in interconnected Power system**: Introductions, Tie - Line Control with Primary Speed Control, Frequency Bias Tie - Line Control, State-Space Models.

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
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</thead>
<tbody>
<tr>
<td>L₃ – Applying.</td>
<td></td>
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</tbody>
</table>

### Module-4

**Automatic Generation Control in interconnected Power system (continued)**: State-Space Model for Two-Area System, Tie-Line Oscillations, Related Issues in Implementation of AGC.


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
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</tr>
</thead>
<tbody>
<tr>
<td>L₃ – Applying.</td>
<td></td>
</tr>
<tr>
<td>Module-5</td>
<td>Teaching Hours</td>
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<tr>
<td>------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
</tr>
</tbody>
</table>

**Course outcomes:**
At the end of the course the student will be able to:

- Describe various levels of controls in power systems, the vulnerability of the system, components, architecture and configuration of SCADA.
- Solve unit commitment problems
- Explain issues of hydrothermal scheduling and solutions to hydro thermal problems
- Explain basic generator control loops, functions of Automatic generation control, speed governors
- Develop and analyze mathematical models of Automatic Load Frequency Control
- Explain automatic generation control, voltage and reactive power control in an interconnected power system.
- Explain reliability, security, contingency analysis, state estimation and related issues of power systems.

**Graduate Attributes (As per NBA)**
Engineering Knowledge, Problem Analysis, Conduct investigations of complex problems, Modern Tool Usage, Communication, Life-long Learning.

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

**Textbook**

|---|-----------------------------------|-----------|-------|-------------------|

**Reference Books**

|---|--------------------------------------|-------------------|-------|-------------------|
B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)  
CHOICE BASED CREDIT SYSTEM (CBCS)  
SEMESTER - VIII  
INDUSTRIAL DRIVES AND APPLICATIONS(Core Course)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>To define electric drive, its parts, advantages and explain choice of electric drive.</td>
</tr>
<tr>
<td>To explain dynamics and modes of operation of electric drives.</td>
</tr>
<tr>
<td>To explain selection of motor power ratings and control of dc motor using rectifiers.</td>
</tr>
<tr>
<td>To analyze the performance of induction motor drives under different conditions.</td>
</tr>
<tr>
<td>To explain the control of induction motor, synchronous motor and stepper motor drives.</td>
</tr>
<tr>
<td>To discuss typical applications electrical drives in the industry.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-1</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Electrical Drives: Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-2</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Current Motor Drives: Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Multiquadrant Operation of dc Separately Excited Motor Fed Form Fully Controlled Rectifier, Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-3</th>
<th>Teaching Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Module-4</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronous Motor Drives: Operation from fixed frequency supply-starting, synchronous motor</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</td>
</tr>
</tbody>
</table>
### Module-5
**Synchronous Motor Drives (continued):** Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives.

**Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor.

**Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.

### Revised Bloom’s Taxonomy Level
- L₁ – Remembering
- L₂ – Understanding
- L₃ – Applying
- L₄ – Analysing

### Course outcomes:
At the end of the course the student will be able to:
- Explain the advantages and choice of electric drive.
- Explain dynamics and different modes of operation of electric drives.
- Suggest a motor for a drive and control of dc motor using controlled rectifiers.
- Analyze the performance of induction motor drives under different conditions.
- Control induction motor, synchronous motor and stepper motor drives.
- Suggest a suitable electrical drive for specific application in the industry.

### Graduate Attributes (As per NBA)
- Engineering Knowledge
- Problem Analysis
- Design/ Development of Solutions
- Modern Tool Usage

### Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

### Textbook

<table>
<thead>
<tr>
<th>Textbook</th>
<th>Edition</th>
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<tbody>
<tr>
<td>1. Fundamentals of Electrical Drives</td>
<td>Narosa Publishing House</td>
</tr>
<tr>
<td>(Refer to chapter 07 for Industrial Drives under module 5.)</td>
<td>2nd Edition, 2011</td>
</tr>
<tr>
<td>VedulaSubrahmanyam</td>
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### Reference Books

<table>
<thead>
<tr>
<th>Reference Books</th>
<th>Edition</th>
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<tbody>
<tr>
<td>Electric Drives</td>
<td>PHI Learning</td>
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</table>
**B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – VIII**

**SMART GRID (Professional Elective)**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Hours</th>
<th>Exam Marks</th>
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</thead>
<tbody>
<tr>
<td>15EE831</td>
<td>20</td>
<td>03</td>
<td>80</td>
</tr>
</tbody>
</table>

**Credits - 03**

**Course objectives:**
- To define smart grid and discuss the progress made by different stakeholders in the design and development of smart grid.
- To explain the measurement techniques using PMUs and smart meters.
- To discuss tools for the analysis of smart grid and design, operation and performance.
- To discuss incorporating performance tools such as voltage and angle stability and state estimation into smart grid.
- To discuss classical optimization techniques and computational methods for smart grid design, planning and operation.
- To discuss the development of predictive grid management and control technology for enhancing the smart grid performance.
- To discuss development of cleaner, more environmentally responsible technologies for the electric system.
- To discuss the fundamental tools and techniques essential to the design of the smart grid.
- To describe methods to promote smart grid awareness and enhancement.
- To discuss methods to make the existing transmission system smarter by investing in new technology.

---

**Module-1**


**Smart Grid Communications and Measurement Technology:** Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Microgrid and Smart Grid Comparison.


|-------------------------------|-----------------------------------------------------|

**Module-2**


|-------------------------------|-------------------------------------------------------------------|

**Module-3**


<table>
<thead>
<tr>
<th>Teaching Hours</th>
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<tbody>
<tr>
<td>08</td>
</tr>
</tbody>
</table>
Module-3 (continued)

Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges.


Revised Bloom’s Taxonomy Level

Module-4


Revised Bloom’s Taxonomy Level
L1 – Remembering, L2 – Understanding.

Module-5


Revised Bloom’s Taxonomy Level
L1 – Remembering, L2 – Understanding.

Course outcomes:
At the end of the course the student will be able to:

- Discuss the progress made by different stakeholders in the design and development of smart grid.
- Explain measurement techniques using Phasor Measurement Units and smart meters.
- Discuss tools for the analysis of smart grid and design, operation and performance.
- Discuss classical optimization techniques and computational methods for smart grid design, planning and operation.
- Explain predictive grid management and control technology for enhancing the smart grid performance.
- Develop cleaner, more environmentally responsible technologies for the electric system.
- Discuss the computational techniques, communication, measurement, and monitoring technology tools essential to the design of the smart grid.
- Explain methods to promote smart grid awareness and making the existing transmission system smarter by investing in new technology.

Graduate Attributes (As per NBA)
Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook

|---|-----------------------------------------------|-------------|------|-------------------|
B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

OPERATION AND MAINTENANCE OF SOLAR ELECTRIC SYSTEMS (Professional Elective)

<table>
<thead>
<tr>
<th>Subject Code</th>
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<tbody>
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<td>Exam Hours</td>
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<tr>
<td>Total Number of Lecture Hours</td>
<td>40</td>
<td>Exam Marks</td>
<td>80</td>
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</tbody>
</table>

Credits - 03

Course objectives:
- To discuss basics of solar resource data, its acquisition and usage.
- To discuss PV technology, buying the PV modules and connecting the modules to form arrays.
- To discuss inverters, system components, cabling used to connect the components and mounting methods of the PV system.
- To explain site assessment, design process of the grid connected system and its sizing.
- To explain installation, commissioning, operation and maintenance of PV systems.
- To explain the types of financial incentives available, calculation of payback time.

Module-1


PV Cells, Modules and Arrays: Characteristics of PV cells, Graphic representations of PV cell performance, Connecting PV cells to create a module, Specification sheets, Creating a string of modules, Creating an array, Photovoltaic array performance, Irradiance, Temperature, Shading.


Module-2

Inverters and Other System Components: Introduction, Inverters, Battery inverters, Grid-interactive inverters, Transformers, Mainstream inverter technologies, String inverters, Multi-string inverter, Central inverter, Modular inverters, Inverter protection systems, Self-protection, Grid protection, Balance of system equipment: System equipment excluding the PV array and inverter, Cabling, PV combiner box, Module junction box, Circuit breakers and fuses, PV main disconnects/isolators, Lightning and surge protection, System monitoring, Metering, Net metering, Gross metering.

Mounting Systems: Roof mounting systems, Pitched roof mounts, Pitched roof mounts for tiled roofs, Pitched roof mounts for metal roofs, Rack mounts, Distributed integrated systems, Ground mounting systems, Ground rack mounts, Pole mounts, Sun-tracking systems, Wind loading, Lightning protection.


Module-3

Site Assessment: Location of the PV array, Roof specifications, Is the site shade-free?, Solar Pathfinder, Solmetric, Suneye, HORIcatcher, iPhone apps, Software packages, Available area, Portrait installation, Landscape installation, Energy efficiency initiatives, Health, safety and environment (HSE) risks, Local environment, Locating balance of system equipment, Site plan.


Sizing a PV System: Introduction, Matching voltage specifications, Calculating maximum voltage, Calculating minimum voltage, Calculating the minimum number of modules in a string, Calculating the maximum voltage, Calculating the maximum number of modules in a string, Calculating the
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

15EE832 OPERATION AND MAINTENANCE OF SOLAR ELECTRIC SYSTEMS
(Professional Elective)(continued)

<table>
<thead>
<tr>
<th>Module-3 (continued)</th>
<th>Teaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum voltage, Calculating the minimum number of modules in a string, Matching current specifications, Matching modules to the inverter’s power rating, Losses in utility-interactive PV systems, Temperature of the PV module, Dirt and soiling, Manufacturer’s tolerance, Shading, Orientation and module tilt angle, Voltage drop, Inverter efficiency, Calculating system yield.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding.</td>
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</table>

<table>
<thead>
<tr>
<th>Module-4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing Grid-connected PV Systems: PV array installation, DC wiring, Cabling routes and required lengths, Cable sizing, PV combiner box, System grounding/earthing, Inverter installation, Installation checklist, Interconnection with the utility grid, Required information for installation, Safety.</td>
<td></td>
</tr>
<tr>
<td>System Operation and Maintenance: System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, Other common problems.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Module-5</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Case Studies: Case studies A to G.</td>
<td></td>
</tr>
<tr>
<td>Revised Bloom’s Taxonomy Level</td>
<td>L₁ – Remembering, L₂ – Understanding.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course outcomes:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of the course the student will be able to:</td>
<td></td>
</tr>
<tr>
<td>• Discuss basics of solar resource data, its acquisition and usage.</td>
<td></td>
</tr>
<tr>
<td>• Explain PV technology, buying the PV modules and connecting the modules to form arrays.</td>
<td></td>
</tr>
<tr>
<td>• Explain the use of inverters, other system components, cabling used to connect the components and mounting methods of the PV system.</td>
<td></td>
</tr>
<tr>
<td>• Assess the site for PV system installation.</td>
<td></td>
</tr>
<tr>
<td>• Design a grid connected system and compute its size.</td>
<td></td>
</tr>
<tr>
<td>• Explain installation, commissioning, operation and maintenance of PV systems.</td>
<td></td>
</tr>
<tr>
<td>• Explain the types of financial incentives available, calculation of payback time.</td>
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<table>
<thead>
<tr>
<th>Graduate Attributes (As per NBA)</th>
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<table>
<thead>
<tr>
<th>Question paper pattern:</th>
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<td>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</td>
<td></td>
</tr>
<tr>
<td>• Each full question with sub questions will cover the contents under a module.</td>
<td></td>
</tr>
<tr>
<td>• Students will have to answer 5 full questions, selecting one full question from each module.</td>
<td></td>
</tr>
</tbody>
</table>
Course objectives:

- To explain power generation by alternate energy source like wind power and solar power.
- To explain selection of size of units and location for wind and solar systems.
- Discuss the effects of integration of distributed generation on the performance the system.
- To provide practical and useful information about grid integration of distributed generation.

Module-1


Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying.

Module-2

**Distributed Generation (continued):** Interface with the Grid.


**Overloading and Losses:** Impact of Distributed Generation, Overloading: Radial Distribution Networks, Overloading: Redundancy and Meshed Operation, Losses.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

Module-3

**Overloading and Losses (continued):** Increasing the Hosting Capacity.


Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.

Module-4

**Voltage Magnitude Variations (continued):** Statistical Approach to Hosting Capacity, Increasing the Hosting Capacity.

**Power Quality Disturbances:** Impact of Distributed Generation, Fast Voltage Fluctuations, Voltage Unbalance.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

Module-5

**Power Quality Disturbances (continued):** Low-Frequency Harmonics, High-Frequency Distortion, Voltage Dips, Increasing the Hosting Capacity.

Revised Bloom’s Taxonomy Level: L₁ – Remembering, L₂ – Understanding.

Course outcomes:

At the end of the course the student will be able to:

- Explain energy generation by wind power and solar power.
- Discuss the variation in production capacity at different timescales, the size of individual units, and the flexibility in choosing locations with respect to of wind and solar systems.
Course outcomes (continued):
- Explain the performance of the system when distributed generation is integrated to the system.
- Discuss effects of the integration of DG: the increased risk of overload and increased losses.
- Discuss effects of the integration of DG: increased risk of overvoltages, increased levels of power quality disturbances.
- Discuss effects of the integration of DG: incorrect operation of the protection.
- Discuss the impact the integration of DG on power system stability and operation.

Graduate Attributes (As per NBA)

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook
<table>
<thead>
<tr>
<th></th>
<th>Integration of Distributed Generation in the Power System</th>
<th>Math Bollen</th>
<th>Wiley</th>
<th>2011</th>
</tr>
</thead>
</table>
Course objectives:
- To discuss the disturbances that may occur in a power system and the impact of them on its viable operation.
- To give the definitions, concepts and standard terminology used in the literature on emergency control and to discuss the effect of system structure on the form of emergency control.
- To discuss the structure, function and alternatives for main transmission.
- To discuss standards of security and quality of supply in planning and operation, timescales and tasks in system operation and control.
- To discuss SCADA facilities - functions, structure, performance criteria, data and human - computer interface.
- To discuss energy management systems, communications, telemetry, telecommand and distributed generation.
- To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk.
- To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration.
- To discuss different simulators that can be used in training.
- To discuss facilities and characteristics for emergency control, qualitative and quantitative benefits of emergency control and emergency control in the future.

Module-1

**Disturbances in Power Systems and their Effects:** Sudden Disturbance, Predictable Disturbances, Forms of System Failure, Analysis Techniques, Trends in the Development of Analytical Techniques.


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying.</th>
</tr>
</thead>
</table>

Module-2


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

Module-3


<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy Level</th>
<th>L₁ – Remembering, L₂ – Understanding, L₃ – Applying, L₄ – Analysing.</th>
</tr>
</thead>
</table>

Module-4

**The Natural Environment - Some Disturbances Reviewed:** Introduction, Useful Sources of Information, Extreme Environmental Conditions, Noteworthy Disturbances, Incidents.
### Module-4 (continued)


| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

### Module-5

**Systems and Emergency Control in the Future:** Introduction, Changes in Organization, Restructuring, Unbundling and Emergency Control, Facilities for Emergency Control in the Future, Superconductivity, Contingency Planning and Crisis.  

| Revised Bloom’s Taxonomy Level | L₁ – Remembering, L₂ – Understanding. |

### Course outcomes:

At the end of the course the student will be able to:

- Explain disturbances that may occur in a power system and the impact of them on its operation.  
- Give the definitions, concepts and standard terminology used in the literature on emergency control and discuss the effect of system structure on the form of emergency control.  
- Discuss the structure, function and alternatives for main transmission.  
- To discuss standards of security and quality of supply in planning and operation, timescales, tasks in system operation and control, SCADA facilities - functions, structure, performance criteria, data and human - computer interface.  
- To discuss energy management systems, communications, telemetry, telecommand and distributed generation.  
- To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk.  
- To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration.  
- To discuss different simulators used in training, facilities and characteristics for emergency control, and benefits of emergency control and emergency control in the future.  

### Graduate Attributes (As per NBA)


### Question paper pattern:

- The question paper will have ten questions.  
- Each full question is for 16 marks.  
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.  
- Each full question with sub questions will cover the contents under a module.  
- Students will have to answer 5 full questions, selecting one full question from each module.  

### Textbook

# Internship / Professional Practice

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Marks</th>
</tr>
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<td>15EE84</td>
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<table>
<thead>
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</thead>
<tbody>
<tr>
<td>--</td>
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<td>0.5</td>
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</tbody>
</table>

## Course objectives:
- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently.

### Internship/Professional practice:
Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

### Seminar:
Each student is required to:
- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

### Revised Bloom’s Taxonomy Level
- L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating

### Course outcomes:
- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics.

### Graduate Attributes (As per NBA):
- Engineering Knowledge
- Problem Analysis
- Design / development of solutions
- Conduct investigations of complex Problems
- Modern Tool Usage
- Engineers and society
- Environment and sustainability
- Ethics
- Individual and Team work
- Communication
### Continuous Internal Evaluation
CIE marks for the Internship/Professional practice report (25 marks) and seminar (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman. ■

### Semester End Examination
SEE marks for the project report (25 marks) and seminar (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■
B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) 
CHOICE BASED CREDIT SYSTEM (CBCS) 
SEMESTER - VIII

PROJECT WORK PHASE - II

<table>
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<td>Credits</td>
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Course objectives:
- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Revised Bloom’s Taxonomy Level
L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating

Course outcomes:
At the end of the course the student will be able to:
- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Graduate Attributes (As per NBA):

Evaluation Procedure:
The Internal marks evaluation shall be based on project report and presentation of the same in a seminar.

Project Report: 50 marks. The basis for awarding the marks shall be the involvement of individual student of the project batch in carrying the project and preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 50 marks. Each student of the project batch shall present the topic of Project Work Phase - II orally and/or through power point slides.
The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman.
The student shall be evaluated based on:
Presentation skill for 30 marks and ability in the Question and Answer session for 20 marks.

Semester End Examination
SEE marks for the project (100 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) as per the University norms by the examiners appointed VTU.
Course objectives:
The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas. Each student, under the guidance of a Faculty, is required to:
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Microsoft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Revised Bloom’s Taxonomy Level

| L3 – Applying, L4 – Analysing, L5 – Evaluating, L6 – Creating |

Course outcomes:
At the end of the course the student will be able to:
- Attain, use and develop knowledge in the field of electrical and electronics engineering and other disciplines through independent learning and collaborative study.
- Identify, understand and discuss current, real-time issues
- Improve oral and written communication skills
- Explore an appreciation of the self in relation to its larger diverse social and academic contexts.
- Apply principles of ethics and respect in interaction with others.

Graduate Attributes (As per NBA):

Evaluation Procedure:
The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman.

Marks distribution for internal assessment of course 15EES86 seminar:
Seminar Report: 30 marks
Presentation skill: 50 marks
Question and Answer: 20 marks.