B. E. SYLLABUS

ELECTRICAL & ELECTRONICS ENGINEERING

V & VI SEMESTER

With
Scheme of Teaching
& Examination
### DEPARTMENT: ELECTRICAL & ELECTRONICS ENGINEERING

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of Faculty</th>
<th>Qualification</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr. Nagesh Prabhu</td>
<td>PhD</td>
<td>Professor &amp; HOD</td>
</tr>
<tr>
<td>2</td>
<td>Dr. Sathyendra Kumar</td>
<td>Ph.D</td>
<td>Professor</td>
</tr>
<tr>
<td>3</td>
<td>Dr. Pius Pinto</td>
<td>Ph.D</td>
<td>Professor</td>
</tr>
<tr>
<td>4</td>
<td>K. Vasudeva Shettigar</td>
<td>M.Tech</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>5</td>
<td>Suryanarayana K</td>
<td>M.Tech (on PhD)</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>6</td>
<td>Nayana P Shetty</td>
<td>M.Tech (PhD)</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>7</td>
<td>Naveen J</td>
<td>M.Tech</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>8</td>
<td>Pradeep Kumar</td>
<td>M.Tech (PhD)</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>9</td>
<td>Latha Shenoy</td>
<td>M.Tech (PhD)</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>10</td>
<td>Anitha Marina Colaco</td>
<td>M.Tech (on PhD)</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>11</td>
<td>Mahabaleshwara Sharma K</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>12</td>
<td>Raksha Adappa</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>13</td>
<td>Dinesh Shetty</td>
<td>M.Tech (PhD)</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>14</td>
<td>Raghavendra Prabhu</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>15</td>
<td>Girisha Joshi</td>
<td>M.Tech (PhD)</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>16</td>
<td>Soumya Rani Mestha</td>
<td>M.Tech (PhD)</td>
<td>Asst. Prof Gd I</td>
</tr>
<tr>
<td>17</td>
<td>Md. Abdul Raheman</td>
<td>M.E</td>
<td>Asst. Prof Gd I</td>
</tr>
<tr>
<td>18</td>
<td>Gururaj K</td>
<td>M.Tech</td>
<td>Asst. Prof Gd I</td>
</tr>
<tr>
<td>19</td>
<td>Ravikiran Rao</td>
<td>M.Tech</td>
<td>Asst. Prof Gd I</td>
</tr>
<tr>
<td>20</td>
<td>Swathi Hatwar H</td>
<td>M.Tech</td>
<td>Asst. Prof Gd I</td>
</tr>
</tbody>
</table>
Vision:
Pursuing excellence in Electrical & Electronics Engineering, creating a research environment to promote innovation and address global challenges.

Mission:
To equip students to face global challenges by excelling in professional career and higher education.
To offer high quality graduate and post graduate programs in electrical & electronics engineering.
To promote excellence in research, collaborative activities and contribute to social development with ethical values.

Programme Educational Objectives (PEOs):
Excel in professional career and / or higher education by acquiring knowledge in mathematical, electrical, electronics and computer engineering principles.
Analyze real life problems, design electrical and electronics & multidisciplinary engineering systems and solutions that are socially acceptable.
Inculcate and exhibit ethical values, communication skills and provide supportive and leadership roles in their profession to emerge as excellent professionals and adapt to current trends by engaging in lifelong learning to promote research.
Programme Outcomes (PO)

At the end of B.E (E&E) program the students will have an ability to

PO1 Engineering knowledge: Apply the knowledge of mathematics, science and engineering fundamentals while practicing Electrical & Electronics Engineering.

PO2 Problem analysis: Identify, formulate, review research literature, analyze complex Electrical & Electronics Engineering problems and draw substantiated conclusions by applying the principles of mathematics, basic science and engineering sciences.

PO3 Design/development of solutions: Design solutions for electrical and electronics engineering problems to meet the specified needs, taking into consideration the public health, safety, cultural, societal, and environmental issues.

PO4 Conduct investigations of complex problems: Investigate Electrical & Electronics Engineering problems using design of experiments, analysis & interpretation of data, to provide valid conclusions.

PO5 Modern tool usage: Create, select, use and apply emerging technologies, skills, and modern engineering and IT tools necessary for practicing Electrical & Electronics Engineering with an understanding of the limitations.

PO6 The engineer and society: Apply the contextual knowledge to assess societal, health, safety, legal, cultural issues and the consequent responsibilities while practicing electrical and electronics engineering profession.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions on society and environment, and demonstrate the need for sustainable development.

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

PO9 Individual and team work: Function effectively as an individual/member or as a leader in diverse teams and contribute to multidisciplinary project.

PO10 Communication: Communicate effectively by comprehending, writing effective reports/design documentation, making effective presentations, and giving & receiving clear instructions.

PO11 Project management and finance: Manage the multidisciplinary projects and finance economically, utilizing the gained knowledge of engineering and management principles.

PO12 Life-long learning: Update and strengthen the knowledge by engaging in lifelong learning to keep pace with technological change.
Program Specific Outcomes (PSO)

PSO1  An ability to demonstrate the electrical engineering concepts by developing working models.
PSO2  An ability to apply embedded system concepts to address electrical engineering problems.
# DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
## SCHEME OF TEACHING AND EXAMINATION

### V Semester

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Code</th>
<th>Course Title</th>
<th>Theory/Tuto./Prac./Self study</th>
<th>Total Hrs./Week</th>
<th>CIE</th>
<th>SEE</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15EE501</td>
<td>Linear Integrated Circuits</td>
<td>4+0+0+0</td>
<td>4</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>15EE502</td>
<td>Digital Signal Processing</td>
<td>3+2+0+0</td>
<td>5</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>15EE503</td>
<td>Linear Control Systems</td>
<td>3+2+0+0</td>
<td>5</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>15EE504</td>
<td>Power Electronics</td>
<td>4+0+0+0</td>
<td>4</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>15EE505</td>
<td>Generation, Transmission and Distribution</td>
<td>4+0+0+S</td>
<td>4</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>15EE506</td>
<td>Transformers and Induction Machines Laboratory</td>
<td>0+0+3+0</td>
<td>3</td>
<td>50</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>15EE507</td>
<td>Circuit and Measurements Laboratory</td>
<td>0+0+2+0</td>
<td>2</td>
<td>50</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>15EE508</td>
<td>Linear System Simulation Laboratory</td>
<td>0+0+2+0</td>
<td>2</td>
<td>50</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>15EE51X</td>
<td>Elective - I</td>
<td>3+0+0+0</td>
<td>3</td>
<td>50</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>15IL001</td>
<td>Employability Skill Development -I</td>
<td>0+1+0+0</td>
<td>1</td>
<td>50</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>33</strong></td>
<td><strong>500</strong></td>
<td></td>
<td><strong>27</strong></td>
</tr>
</tbody>
</table>

15EE511    | Power Semiconductor Devices
15EE512    | Energy Management & Audit
15EE513    | Operating System
15EE514    | Fuzzy Logic Control
15EE515    | Advanced Instrumentation System
# DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
## SCHEME OF TEACHING AND EXAMINATION

### VI Semester

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code</th>
<th>Course Title</th>
<th>Theory/Tuto. /Prac./Self study</th>
<th>Total Hrs./Week</th>
<th>CIE</th>
<th>SEE</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15EE601</td>
<td>Power Systems Analysis &amp; Stability</td>
<td>3+2+0+0</td>
<td>5</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>15EE602</td>
<td>Switchgear and Protection</td>
<td>4+0+0+S</td>
<td>4</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>15EE603</td>
<td>Electrical Machine Design and CAD</td>
<td>3+2+0+0</td>
<td>5</td>
<td>50</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>15EE604</td>
<td>Power Electronics Laboratory</td>
<td>0+0+3+0</td>
<td>3</td>
<td>50</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>15EE605</td>
<td>Electrical CAD Laboratory</td>
<td>0+0+2+0</td>
<td>2</td>
<td>50</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>15EE606</td>
<td>Linear IC and Control Systems Laboratory</td>
<td>0+0+3+0</td>
<td>3</td>
<td>50</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>15EE607</td>
<td>IGW* will be held for one week during specified slot in the semester and will be a non-credit mandatory course.</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>15IL002</td>
<td>Employability Skill Development -II</td>
<td>0+1+0+0</td>
<td>1</td>
<td>50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>15EE61X</td>
<td>Elective – II</td>
<td>3+0+0+0</td>
<td>3</td>
<td>50</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>15EE62Y</td>
<td>Elective – III</td>
<td>3+0+0+0</td>
<td>3</td>
<td>50</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>29</strong></td>
<td><strong>29</strong></td>
<td>500</td>
<td>500</td>
<td><strong>23</strong></td>
</tr>
</tbody>
</table>

*IGW* - Indispensable Group Work
### ELECTIVE – II

<table>
<thead>
<tr>
<th>15EE61X</th>
<th>15EE611</th>
<th>Switched Mode Power Converter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15EE612</td>
<td>Renewable Energy Sources</td>
</tr>
<tr>
<td></td>
<td>15EE613</td>
<td>Introduction to ASIC and FPGA Design</td>
</tr>
<tr>
<td></td>
<td>15EE614</td>
<td>Advanced Control Theory</td>
</tr>
<tr>
<td></td>
<td>15EE615</td>
<td>Operations Research</td>
</tr>
</tbody>
</table>

### ELECTIVE - III

<table>
<thead>
<tr>
<th>15EE62Y</th>
<th>15EE621</th>
<th>Power Electronics System Design using ICs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15EE622</td>
<td>OOPS using C++</td>
</tr>
<tr>
<td></td>
<td>15EE623</td>
<td>ARM System Architecture</td>
</tr>
<tr>
<td></td>
<td>15EE624</td>
<td>Programmable Logic Controllers</td>
</tr>
<tr>
<td></td>
<td>15EE625</td>
<td>Illumination Technology</td>
</tr>
</tbody>
</table>
LINEAR INTEGRATED CIRCUITS

Sub Code : 15EE501
Credits : 04
Hrs/Week : 4+0+0+0
Total Hours : 52

Prerequisites
Basic Electronics (15EC112), Analog Electronics Circuits (15EE304)

Course Learning Objectives:

1. To differentiate ideal and practical op-amp and identify various practical op-amp specifications and measure offset error voltages / currents and other critical parameters.
2. To analyze and design the direct coupled and capacitor coupled operational amplifier circuits. And discuss op-amp circuit stability issues and frequency compensating methods.
3. To demonstrate the use of op-amp in signal processing applications, active filters and design such circuits.
4. To analyze the non-linear behavior of the op-amp and design op-amp circuits in open loop and with positive feedback.

UNIT – I

Operational Amplifier: The basic operational amplifier, Ideal Op-Amp concept, Practical Op-Amps, OP-AMP as a DC amplifier, Differential amplifier, Offset error voltages and currents. Measurement of operational amplifier parameters. 7 Hours

OP-AMP as an AC Amplifier: Capacitor Coupled Voltage Follower, High Zin capacitor coupled voltage follower, capacitor coupled non-inverting amplifier, High Zin capacitor coupled non-inverting amplifier, Capacitor coupled inverting amplifier 4 Hours

UNIT – II

Setting upper cut-off frequency, capacitor coupled difference amplifier, use of single polarity supply. 3 Hours

OP-AMP Frequency Response and Compensation: Op-Amp circuit stability, frequency and phase response, frequency compensating methods, Manufacturer’s recommended compensation, op-amp circuit bandwidth, slew rate effects, stray capacitance effects, load capacitance effects, Zin Mod compensation, Circuit stability precautions. 8 Hours

UNIT – III

OP-AMP Nonlinear Circuits-1: Precision Half wave and full wave rectifiers, limiting circuits, Clamping circuits, peak detectors, sample and hold circuits. V/F and F/V Converters. 5 Hours

OP-AMP Nonlinear Circuits-2: Op-Amps in switching circuits, crossing detectors, inverting Schmitt trigger circuits, Non-inverting circuits, Astable multivibrators, Monostable multivibrators, op-amp based SCR triggering circuit. 5 Hours
UNIT – IV

**Active Filters:** First and Second order high pass and low pass filters. Band pass filter, Band stop filters. Higher order filters.  
**Specialized IC Applications:** Universal active filters, Phase locked loops, Power amplifiers.

6 Hours

UNIT – V

**555 TIMER** - Monostable and Astable multivibrators and applications 3 Hours

**DC-Voltage Regulators:** Voltage regulator basics, Voltage follower regulator, adjustable output regulator, Precision voltage regulator, Integrated Circuit voltage Regulator. 8 Hours

**Course Outcomes:**

At the end of the course student will be able to

1. Analyze the op-amp parameters and understand their limitations and applications as AC amplifier.
2. Discuss op-amp frequency dependence, circuit stability issues and frequency compensating methods.
3. Demonstrate the use of op-amp in signal processing applications, non-linear applications with positive feedback.
4. Design and use op-amp in an active filters circuits. Demonstrate the use of specialized IC’s.
5. Analyze and design application circuits using 555 timers and study various voltage regulators.

**Mapping of POs & COs:**

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TEXT BOOKS :**

2. Ramakanth Gayakwad, Operational Amplifiers and Linear IC’s, 4th edition — Prentice Hall, 2000..

**REFERENCE BOOKS :**


E-Books / MOOC
1. Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware | Reviews and Ratings
2. https://www2.mvcc.edu/users/faculty/jfiore/OpAmps/OperationalAmplifiersAndLinearICs_3E.pdf
4. https://inst.eecs.berkeley.edu/~ee140/sp14/lectures.html
5. Texas Instrument Videos on Amplifiers Available at https://www.youtube.com/playlist?list=PLISmVLHAZbTS78B14s_uMovo0izTdSMCr

DIGITAL SIGNAL PROCESSING

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>Credits</th>
<th>Hrs/Week</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE502</td>
<td>04</td>
<td>3*+2+0+0</td>
<td>39*+26</td>
</tr>
</tbody>
</table>

*Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites
VCTT (15EE301), PTNM (15EE401), ENT-I (15EE302), ENT-II (15EE405)

Course Learning Objectives:
1. To understanding the basic elements of dsp and review of DTFT and Z tranform
2. To understand the filtering of long sequence and the FFT algorithm for time and frequency domain.
3. To Illustrate the design and implementation of digital filters and spectral analyzers, and in their application to real signals.
4. To demonstrate the design and implementation of IIR filters and spectral analyzers.
5. To understand the different structures of IIR and FIR filter
6. To understand the concept of quantization, truncation and rounding

UNIT – I

Basic elements of DSP – concepts of frequency in Analog and Digital Signals – sampling theorem Discrete time signals, systems – Analysis of discrete time LTI systems – Review of DTFT and Z transform – Convolution – Correlation. 8*+5 Hours

UNIT - II

FREQUENCY TRANSFORMATIONS
Syllabus of V & VI Semester B.E. / Electrical & Electronics Engg.


8*+5 Hours

UNIT – III

IIR FILTER DESIGN
Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives – (LPF, HPF, BPF, BRF) filter design using frequency translation.  

8*+5 Hours

UNIT – IV


8*+5 Hours

UNIT – V

FINITE WORD LENGTH EFFECTS IN DIGITAL FILTERS
Binary fixed point and floating point number representations – Comparison - Quantization noise – truncation and rounding – quantization noise power- input quantization error-coefficient quantization error –limit cycle oscillations-dead band- Overflow error-signal scaling.  

7*+5 Hours

Course Outcomes:
At the end of the course student will be able to
1. Analyze the signals in discrete time domain
2. Convert the signals from analog domain to digital domain
3. Design and implement filters using infinite impulse response techniques
4. Design and implement filters using finite impulse response techniques
5. Analyze the various kinds of errors taking place while sampling

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>H</td>
<td></td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>H</td>
<td>L</td>
<td></td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>H</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOK :
REFERENCE BOOKS:

E-Books / MOOC:
1. The Scientist and Engineer’s Guide to Digital Signal Processing By Steven W. Smith, Ph.D.
4. http://nptel.ac.in/courses/117102060/
6. Sign up at http://www.coursera.org/course/dsp

******************************

LINEAR CONTROL SYSTEMS

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>15EE503</th>
<th>Credits</th>
<th>04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hrs/Week</td>
<td>3*+2+0+0</td>
<td>Total Hours</td>
<td>39*+26</td>
</tr>
</tbody>
</table>

*Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites
VCTT (15EE301), PTNM (15EE401)

Course Learning Objectives:

1. To introduce modeling and analysis of electrical, electromechanical and mechanical systems.
2. To familiarize the students with analytical and graphical techniques to study the stability of control systems and design the control system.
3. To make the students familiar with the time domain and frequency domain analysis.

UNIT – I

Modeling of Systems: The control system, Mathematical models of physical systems – electrical Mechanical, electro-mechanical systems, (Mechanical accelerometer, Levered systems excluded), Gear trains, Analogous systems, Introduction to state space modeling simple systems. 8*+5 Hours

UNIT – II

Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded) 5*+3 Hours
**Time Response of feedback control systems:** Standard test signals, UNIT step response of First and second order systems, Time response specifications, Time response specifications of second order systems, steady – static errors and error constants.  

**UNIT – III**

**Stability analysis:** Concepts of stability, Necessary conditions for Stability, Routh- stability criterion, Relative stability analysis  


**UNIT – IV**

**Frequency domain analysis:** frequency response specification, Correlation between time and frequency response, Bode plots, All pass, minimum & non-minimum phase systems, Assessment of relative stability using Bode Plots, determination of transfer functions from bode plots.  

**UNIT – V**

**Polar plots, Nyquist Criteria:** Mathematical preliminaries, Nyquist Stability criterion, Assessment of relative stability using Nyquist plots  

**Compensators and Controllers:** Compensators, lead lag networks, Controllers P, PI, PID (qualitative analysis)  

**Course Outcomes:**

At the end of the course student will be able to

1. Develop mathematical model of linear systems and model reduction using block diagram and signal flow graphs.  
2. Perform the time domain analysis of control system.  
3. Demonstrate the concept of stability.  
4. Analyze the transfer function of the physical systems for stability using different control techniques.  
5. Expound the frequency domain analysis of given system.  

**Mapping of POs & COs:**

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>H</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>H</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TEXT BOOKS:

REFERENCE BOOKS:

E-Books / MOOC:
2. http://www.facstaff.bucknell.edu/mastascu/eControlHTML/CourseIndex.html
3. https://see.stanford.edu/Course/EE263
5. www.nptel.com/IITK
6. https://www.edx.org/course/
7. http://nptel.ac.in/courses/108103007/1

************************************************

POWER ELECTRONICS

Sub Code : 15EE504
Hrs/Week : 4+0+0+0
Credits : 04
Total Hours : 52

Prerequisites
Basic Electronics (15EC112), AEC (15EE304),

Course Learning Objectives:
1. To understand types and the characteristic of power semiconductor devices, converters
2. To familiarize the principle of operation of thyristors with their characteristics
3. To describe the principle of operation of AC voltage controller, controlled rectifiers circuits and evaluation of performance parameters.
4. To get acquainted with the different types of chopper configurations and methods of control.
5. To understand the principle of operation of single phase and three phase inverters circuits.
UNIT – I


UNIT – II

Thyristors: Introduction, characteristics. Two Transistor Model. Turn-on and turn-off. di/dt and dv/dt protection. Thyristor types. Series and parallel operation of Thyristors. Thyristor firing circuits, UJT, Sample design of firing circuits using UJT.


UNIT – III


UNIT – IV


UNIT – V


Course Outcomes:

At the end of the course student will be able to

1. Distinguish different types of power semiconductor devices, converters and their characteristics.
2. Explain the principle of operation of thyristors with their characteristics and analyze various thyristor firing circuits, commutation methods and protection circuits used.
3. Describe the principle of operation of AC voltage controller, controlled rectifiers circuits and evaluation of performance parameters.
4. Explain different types of chopper configurations and methods of control.
5. Describe the principle of operation of single phase and three phase inverters circuits.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>L</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOK :

REFERENCE BOOKS :

E-Books / MOOC:
1. E course material on power electronics available at nptel.ac.in/courses/108105066/
2. www.powerelectronics.com/learning-resources/ebooks
3. NPTEL Video Lecture on “Power Electronics” nptel.ac.in/courses/108101038/#
4. www.coursera.org/learn/power-electronics
5. ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/

GENERATION, TRANSMISSION AND DISTRIBUTION

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>15EE505</th>
<th>Credits</th>
<th>04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hrs/Week</td>
<td>4+0+0+S*</td>
<td>Total Hours</td>
<td>52</td>
</tr>
</tbody>
</table>

*Self-Study Topics – To be covered under the supervision of the course instructors.
Prerequisites: BEE (15EE105)

Course Learning Objectives :
1. To understand the concepts of various methods of generation of power.
2. To understand the concept of economic aspects and transmission and distribution schemes
3. To find various parameters pertaining to overhead transmission lines and select insulators
4. To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
5. To understand the characteristics & performance of power transmission lines.

UNIT – I

**Electrical Power Generation:** Hydro Power generation—selection of site, classification of hydroelectric plants, general arrangement and operation, hydroelectric plant power station structure and control.
Thermal Power generation—Introduction, main parts, working, plant layout, Diesel Electric plants, Gas turbine plants-components, layout, advantages over steam turbine plant
Nuclear Power Station—Introduction, Adverse effects of fossil fuels, components of reactors, Description of fuel sources, Pros and Cons of nuclear power generation, Safety of nuclear power reactor
**SS Topic:** concept of co-generation

UNIT – II

**Economics Aspects:** Introduction, Terms commonly used in system operation, Definitions of diversity factor, load factor, plant capacity factor, plant use factor, plant utilization factor, loss factor. Load duration curve, energy load curve and types of tariffs.

**Typical transmission & distribution systems scheme:** General layout of power system, Standard voltages for transmission. Requirement of EHV transmission, Advantage of high voltage transmission. Feeders,
**SS Topic:** distributors & service mains.

**Distribution:** Requirements of power distribution, ac distribution - radial & ring main systems calculation for concentrated loads.

UNIT – III

**Overhead transmission lines:** sag calculation in conductors a) suspended on level supports b) support at different levels. Effect of wind & ice tension & sag at erection, Line vibration damper.

**Insulators:** Types, potential distribution over a string of suspension insulators. String efficiency & methods of increasing strings efficiency, Testing of insulators.
**SS Topic:** Insulation coordination – need and principle (qualitative).

UNIT – IV

**Underground cables:** Types, material used, insulation resistance, thermal rating of cables, charging current, Grading of cables, capacitance grading.
**SS Topic:** Inter sheath grading.

**Line parameters:** calculation of inductance of single phase, 3phase lines with equilateral & unsymmetrical spacing. Inductance of composite conductor lines (GMR and GMD), capacitance calculation for single circuit and double circuit three-phase line with equilateral
& unsymmetrical spacing.  

6 Hours

UNIT – V

Characteristics & performance of power transmission lines: Short transmission lines, medium transmission lines- nominal T, end condenser and pi models,

SS Topic: long transmission lines  

5 Hours

ABCD constants of transmission lines, Ferranti effect, line regulation.
Introduction FACTS & HVDC Transmission  

5 Hours

Course Outcomes:

At the end of the course student will be able to

1. Illustrate methods of generation of electrical power and their pros and cons
2. Appreciate the economic aspects of electrical power and typical transmission & distribution systems scheme.
3. Demonstrate the concepts associated with overhead transmission line and insulators
4. Interpret the concepts associated with underground cables and line parameters
5. Comprehend the characteristics & performance of power transmission lines and introduce the concept of FACTS and HVDC.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>H</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>H</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS :


REFERENCE BOOKS :


E-Books / MOOC
1. Energy scenario: https://beeindia.gov.in/sites/default/files/1Ch1.pdf
3. https://www.coursera.org/learn/electric-utilities

********************

TRANSFORMERS AND INDUCTION MACHINES LABORATORY

Sub Code : 15EE506
Hrs/Week : 0+0+3+0

Credits : 02
Total Hours : 39

Course Learning Objectives:

1. To familiarize the methods of testing transformer efficiency and regulation.
2. To understand the torque slip characteristics of an induction machine.
3. To perform the speed control of three phase induction machine.
4. To get acquainted to Parallel operation and three phase connections of single phase transformers.

List of Experiments
2. Sumpner’s test.
3. Parallel operation of two dissimilar (different KVA) 1-phase transformers.
4. Polarity test & connection of 3 single phase transformers in star – delta and determination of efficiency & regulation – for balanced direct loading for UPF.
5. Scott connection- for balanced and unbalanced two phases UPF loads.
8. Obtain the equivalent circuit diagram of a 3-phase I.M. & from equivalent circuit diagram obtain its performance evaluation.
9. Speed control of 3-phase induction motor- stator voltage control & rotor resistance control (performance circuits for at least two different voltages/ two rotor resistance values).
10. Load test on induction generator.
11. Load test on 1 phase induction motor.
12. Speed control of 3-phase induction motor by V/f method

Course Outcomes:

At the end of the course student will be able to
1. Test the transformer for its efficiency and regulation.
2. Determine torque slip characteristics of an induction machine.
3. Control the speed of three phase induction machine.
4. Parallel operation and three phase connections of single phase transformers
5. Performance evaluation of 3-phase induction machine using circle diagram and equivalent circuit analysis.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E Books

*****************************

CIRCUITS AND MEASUREMENTS LABORATORY

Sub Code : 15EE507
Hrs/Week : 0+0+2+0
Credits : 01
Total Hours : 26

Course Learning Objectives :

1. To understand the process to Verify various network theorems
2. To measure circuit parameters using bridges.
3. To understand the procedures to Measure active and reactive power in three phase circuit.
4. To Know the calibration procedures for 1-phase energy meter and Determine ratio & phase angle error in CT.

List of Experiments

1. Measurement of low resistance using Kelvin Double Bridge.
4. First order R-L and R-C circuits.
5. Second order RLC Circuits
6. Sinusoidal Steady State Analysis
7. Verification of Superposition and Reciprocity theorems
8. Verification of Thevenin’s, Norton’s theorem
9. Verification of Maximum power transfer theorem
10. Measurement of active and reactive power in balanced 3-phase circuit using two-watt meter method.
11. Characteristics of series and Parallel resonance
12. Determination of ratio & phase angle error in CT.

Course Outcomes:

At the end of the course student will be able to
1. Verify various network theorems and
2. Measure circuit parameters i.e resistances, capacitance and inductance using bridges
3. Measure active and reactive power in three phase circuit.
4. Verify the concept of resonance.
5. Adjust & calibrate 1-phase energy meter and Determine ratio & phase angle error in CT.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

********************

LINEAR SYSTEM SIMULATION LABORATORY

Sub Code : 15EE508
Hrs/Week : 0+0+2+0
Credits : 01
Total Hours : 26

Course Learning Objectives :

1. To verify various control systems concepts using simulation software.
2. To understand the signal processing concepts using simulation softwares

Following experiments to be simulated using MATLAB / Simulink (or Equivalent)

1. Simulation of a typical second order system and determination of step response and frequency response to evaluate time domain specifications & frequency domain specifications.
2. Simulate a D. C. position control system and obtain its step response.
3. Obtain the phase margin and gain margin for a given transfer function by drawing bode plots and verify the same.
4. To draw the root loci for a given transfer function and verification of breakaway point and imaginary axis cross axis.
5. To draw Polar plot, Nyquist plot for a given transfer function and verification of stability
6. Verification of Sampling theorem and obtaining Impulse response of a given system
7. Linear convolution of two given sequences by direct method and using DFT and IDFT
8. Circular convolution of two given sequences by direct method and using DFT and IDFT
9. Solving a given difference equation.
10. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum.
11. Design and implementation of FIR filter to meet given specifications.
12. Design and implementation of IIR filter to meet given specifications

**Course Outcomes:**

At the end of the course student will be able to

1. **Mapping of POs & COs:**

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

***********************

**POWER SEMICONDUCTOR DEVICES**

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>15EE511</th>
<th>Credits</th>
<th>03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hrs/Week</td>
<td>3+0+0+0</td>
<td>Total Hours</td>
<td>39</td>
</tr>
</tbody>
</table>

**Prerequisites:** Knowledge of Basic Semiconductor devices.

**Course Learning Objectives :**

1. To understand the principle of operation of MOSFET and IGBT with their characteristics and effect of reverse recovery transients on switching stresses & losses
2. To the construction and features of the emerging power electronic devices
3. To Illustrate the importance of gate drive circuits for power devices, design of snubber and heat sink.
Introduction: Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); selection strategy – On-state and switching losses – EMI due to switching – Power diodes – Types, forward and reverse characteristics, switching characteristics – rating

UNIT – II


UNIT – III

Power IGBT: basic structure & operation, i-v characteristics, Latch-up in IGBT, Switching characteristics: turn-on, Turn-off transient, current tailing, Switching losses, Device limits & SOA, Over-current & short-circuit protection of IGBT

UNIT – IV

Power Electronics Devices: Construction and features of - Phase Controlled thyristors, inverter graded thyristors, ASCR, RCT, SUS, SBS, SCS,GTO, MCT, SIT, IGCT, MTO, ETO, PIC. Comparison of power devices.

UNIT – V

Firing and Protecting Circuits: Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers, Guidance for heat sink selection, heat sink types and design – Mounting types.

Course Outcomes:

At the end of the course student will be able to
1. Overview of power semiconductor devices with selection strategy, types and characteristics of power diodes
2. Explain the principle of operation of MOSFET with their characteristics and effect of reverse recovery transients on switching stresses & losses
3. Explain the principle of operation of IGBT with their characteristics and protection against over-current & short-circuit
4. Demonstrate the construction and features of the emerging power electronic devices
5. Illustrate the importance of gate drive circuits for power devices, design of snubber and heat sink.
Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>CO1</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOKS:

E-Books / MOOC:
1. Module 1 of http://www.nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Power%20Electronics/New_index1.html
2. https://www.coursera.org/learn/converter-circuits/lecture/b5VYY/sect-4-2-0-introduction-to-power-semiconductors

*******************
ENERGY MANAGEMENT AND AUDIT

Sub Code : 15EE512                     Credits : 03
Hrs/Week : 3+0+0+0                    Total Hours : 39

Course Learning Objectives:

1. To understand the energy situation and need for energy economic analysis.
2. To know the concept of energy auditing.
3. To Comprehend various energy tariffs and understand the need for pf correction.
4. To understand the need for Electrical System Optimization.
5. To Implement the concept of Demand Side Management.

UNIT – I

Introduction: Energy situation – world and India, energy consumption, conservation. Codes, standards and Legislation. 4 Hours

Energy Economic Analysis: The time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit – numerical problems. 4 Hours

UNIT – II

Energy Auditing: Introduction, Elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results. 8 Hours

UNIT – III

Electrical Equipment and power factor – correction & location of capacitors, energy efficient motors, lighting basics, electrical rate tariff. 8 Hours

UNIT – IV

Electrical System Optimization: The power triangle, motor horsepower, power flow concept. 7 Hours

UNIT – V

Demand Side Management: Introduction to DSM, concept of DSM, benefits of DSM, different techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning, load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. Management and Organization of Energy Conservation awareness Programs. 8 Hours

Course Outcomes:

At the end of the course student will be able to

1. Interpret the energy situation and need for energy economic analysis.
2. Illustrate the concept of energy auditing.
3. Comprehend various energy tariffs and understand the need for pf correction.
4. Outline the need for Electrical System Optimization.
5. Implement the concept of Demand Side Management

### Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

### TEXT BOOKS:

### REFERENCE BOOKS:
4. Hand book on energy auditing - TERI (Tata Energy Research Institute)

### E-Books / MOOC
1. https://www.coursera.org/learn/electric-utilities
2. http://www.nptel.ac.in/courses/108106022/

### OPERATING SYSTEM

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>15EE513</th>
<th>Credits : 03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hrs/Week</td>
<td>3+0+0+0</td>
<td>Total Hours : 39</td>
</tr>
</tbody>
</table>

### Course Learning Objectives:
1. To introduce the operating systems concepts.
2. To explain the concepts of structure of operating systems
3. To illustrate the process management and treads in operating systems
4. To illustrate the memory management and memory allocation in operating systems.
5. To introduce the concept of virtual memory in operating systems with example of UNIX.
UNIT – I
Introduction And Overview Of Operating Systems : Operating system, Goals of an O.S, Operation of an O.S, Resource allocation and related functions, User interface related functions, Classes of operating systems, O.S and the computer system, Batch processing system, Multi programming systems, Time sharing systems, Real time operating systems, distributed operating systems. 08 Hours

UNIT – II
Structure of the Operating Systems: Operation of an O.S, Structure of the supervisor, Configuring and installing of the supervisor, Operating system with monolithic structure, layered design, Virtual machine operating systems, Kernel based operating systems, and Microkernel based operating systems. 8 Hours

UNIT – III
Process Management: Process concept, Programmer view of processes, OS view of processes, Interacting processes, Threads, Processes in UNIX, Threads in Solaris. 7 Hours

UNIT – IV
Memory Management: Memory allocation to programs, Memory allocation preliminaries, Contiguous and noncontiguous allocation to programs, Memory allocation for program controlled data, kernel memory allocation. 7 Hours

UNIT – V
Virtual Memory: Virtual memory basics, Virtual memory using paging, Demand paging, Page replacement, Page replacement policies, Memory allocation to programs, Page sharing, UNIX virtual memory. Scheduling: Fundamentals of scheduling, Long-term scheduling, Medium and short term scheduling, Real time scheduling, Process scheduling in UNIX. 9 Hours

Course Outcomes:
At the end of the course student will be able to
1. Present an overview of operating systems and concepts related to it.
2. Explain the concepts of structure of operating systems.
3. Justify the concept of process management and threads in operating systems.
4. Illustrate the memory management and memory allocation in operating systems.
5. Introduce the concept of virtual memory in operating systems with example of UNIX.
Syllabus of V & VI Semester B.E. / Electrical & Electronics Engg.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOKS:

******************

FUZZY LOGIC CONTROL

Sub Code : 15EE514
Hrs/Week : 3+0+0+0
Credits : 03
Total Hours : 39

Course Learning Objectives :

1. To Know the basics of Fuzzy logic
2. To Differentiate between fuzzy and linguistic variables and study the concept of inference rules
3. To Demonstrate Fuzzy control systems.
4. To understand the fuzzy knowledge based controllers (FKBC)
5. To understand Process of performance monitoring, adaption mechanism.

UNIT – I

Introduction: Fuzzy sets, Properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, cardinality operations on fuzzy relations, Fuzzy Cartesian product and composition, fuzzy Tolerance and equivalence relations. 7 Hours
UNIT – II

Theory of approximate reasoning: Linguistic variables, linguistic hedges, Fuzzy if then statements, inference rules, compositional rule of inference, graphical technique of inference, Fuzzification and defuzzification procedures. 8 Hours

UNIT – III

Development of membership functions-intuition, inference, rank ordering, neural networks, genetic algorithm, inductive reasoning Assumptions in a Fuzzy control system design, Simple fuzzy logic controllers, Examples of fuzzy logic controllers. 10 Hours

UNIT – IV

Fuzzy knowledge based controllers (FKBC): Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, FKBC as a linear transient element, Design of P, PI, PD, PID controllers, sliding mode FKBC, Sugeno FKBC. 8 Hours

UNIT – V

ADAPTIVE FUZZY CONTROL: Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller, Model based controller. 6 Hours

Course Outcomes:

At the end of the course student will be able to
1. Know the basics of Fuzzy logic
2. Differentiate between fuzzy and linguistic variables and study the concept of inference rules
3. Demonstrate Fuzzy control systems.
4. Interpret fuzzy knowledge based controllers (FKBC)
5. Analyze Process of performance monitoring, adaption mechanism.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td>CO1</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO2</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO3</td>
<td>L</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO4</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO5</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:


REFERENCE BOOKS :

E-Books / MOOC/ NPTEL
1. http://nptel.ac.in/courses/108104049/
2. http://videolectures.net/acai05_berthold_fl/

************************

ADVANCED INSTRUMENTATION SYSTEM

Sub Code : 15EE515
Credits : 03
Hrs/Week : 3+0+0+0
Total Hours : 39

Prerequisites
BEE (15EE105), EEMI (15EE306)

Course Learning Objectives :
1. To Know the various aspects of instrumentation.
2. To understand the various measuring instruments and their characteristics.
3. To Comprehend with the working of various transducers.
4. To Appreciate the need of Data acquisition, conversion and transmission.

UNIT – I

Instrumentation: Frequency meter, measurement of time and frequency (mains), tachometer, phase meter, capacitance meter. Automation in digital Instrumentation. 7 Hours

UNIT – II

Analyzer: Wave analyzers and Harmonic distortion, Basic wave analyzer, Frequency selective wave analyzer, Harmonic distortion analyzer and Spectrum analyzer. 8 Hours

UNIT – III

Measuring Instruments: Output power meters, Field strength meter Vector impedance meter, Q meter applications-Z, Z_0 and Q. Basic LCR bridge, RX meters. 5 Hours
Measurement of power: Measurement of large amount of RF power (calorimetric method), measurement of power on a transmission line, standing wave ratio measurements.  

4 Hours

UNIT – IV

Transducers: Synchro’s, Capacitance Transducers, Load cells, Piezo electrical Transducers, IC type temperature sensors, Pyrometers, Ultrasonic temperature Transducer, Reluctance pulse pick-ups, Flow measurement-mechanical Transducers; Magnetic flow meters, turbine flow meters. \( \beta \)-gauge.  

8 Hours

UNIT – V

Data acquisition and conversion: Generalized data acquisition system (DAS), Signal conditioning of inputs, single channel DAS, multi channel DAS, data loggers, compact data logger.  


3 Hours

Course Outcomes:

At the end of the course student will be able to

1. Demonstrate various aspects of instrumentation.
2. Appreciate the need of analyzer.
3. List various measuring instruments and understand their characteristics. Also understand the concept of measurement of power.
4. Comprehend with the working of various transducers.
5. Appreciate the need of Data acquisition, conversion and transmission.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \downarrow ) Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCE BOOKS:


***********************
POWER SYSTEMS ANALYSIS & STABILITY

Sub Code : 15EE601  
Credits :  04  
Hrs/Week : 3*+2+0+0  
Total Hours : 39*+26

* Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites  
15EE105 (BEE), 15EE405 (NA), 15EE303 (DCSM)

Course Learning Objectives:

1. To gain the knowledge pertaining to network representation: per-UNIT system, balanced networks, and single line diagrams.
2. To introduce Power systems components and their modelling
3. To illustrate various symmetrical & unsymmetrical faults in power system, symmetrical components, selection of circuit breakers.
4. To introduce the concept of rotor dynamic, swing equation, and power system stability.

UNIT – I

REPRESENTATION OF POWER SYSTEM COMPONENTS: Circuit models of Transmission line, Synchronous machines, Transformer and Load. One line diagram, Impedance diagram, Per UNIT notation, Selection and change of base for Per UNIT quantities, Per UNIT Impedance diagram of power system. 

8*+5 Hours

UNIT – II

SYMMETRICAL 3 PHASE FAULTS: Short Circuit currents and reactance of Synchronous machines, Short circuit current calculations of unloaded and loaded Generators and Power Systems, symmetric short circuit MVA calculations, Short circuit current computation through Thevinin's theorem, Selection of circuit breakers.

8*+5 Hours

UNIT – III

SYMMETRICAL COMPONENTS: Symmetrical component transformation, Resolution of unbalanced phasors into their symmetrical components and vice-versa, Power in terms of symmetrical components, Phase shift of symmetrical components in Star – Delta transformer bank. Positive, Negative and Zero Sequence impedances and Sequence networks of power system elements (Transmission line, Synchronous machine and Transformer).

8*+5 Hours
UNIT – IV

UNSYMMETRICAL FAULTS: Symmetrical component analysis of Unsymmetrical faults, Line-To-Ground (L-G), Line-To-Line (L-L), Double Line-To-Ground (L-L-G) faults on an Unloaded Alternator and Power System with and without fault impedance and connections of sequence networks. Open conductor faults in power systems. 7*+6 Hours

UNIT- V

POWER SYSTEM STABILITY: Steady-state and Transient stability, Rotor dynamics and the Swing equation, Power angle equation. Equal – Area criterion of stability and its applications. Numerical solution of swing equation. 8*+5 Hours

Course Outcomes:

At the end of the course student will be able to
1. Demonstrate the knowledge gained pertaining to network representation: per-UNIT system, balanced networks, single line diagrams.
2. Analyze Power systems components and modelling: transformers, transmission lines, cables, rotating machines, and loads.
3. Comprehend symmetrical & unsymmetrical faults in power system, symmetrical components, selection of circuit breakers.
4. Analyze Rotor dynamic, swing equation, concepts of power system stability.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes →</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td>√</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOK:

E Books / NPTEL / MOOC
1. http://nptel.ac.in/courses/108105067/
2. http://nptel.ac.in/courses/108106026/

******************************
SWITCHGEAR AND PROTECTION

Sub Code : 15EE602  Credits : 04
Hrs/Week : 4+0+0+S*  Total Hours : 52

* Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.

Prerequisites
Basic Electrical Engineering (15EE105), IM (15EE306)

Course Learning Objectives :

1. To understand the basic equipment in power system/substation.
2. To recognize the different grounding systems implemented in power systems.
3. To analyze the construction and working of different types of circuit breakers used in power systems.
4. To study the characteristics and working of various types of relays
5. To understand the various protection schemes.

UNIT – I

Switches and fuses: Isolating switch, load breaking switch, Fuse law, cut-off characteristics, Time current characteristics, fuse material, HRC fuse, liquid fuse, Application of fuse.  4 Hours

Grounding Systems: Introduction, resistance grounding systems, neutral grounding, ungrounded system, resonant grounding, solid grounding, reactance grounding, resistance grounding, earthing transformer, SS Topic: neutral grounding transformer.  7 Hours

UNIT – II


SS Topic: resistance switching.

UNIT – III

Circuits Breakers: Air Circuit breakers – Air break and Air blast Circuit breakers, oil Circuit breakers - Single break, double break and minimum OCB, SF6 breaker - Preparation of SF6 gas, Puffer and non Puffer type of SF6 breakers.  6 Hours

Vacuum circuit breakers - Construction, principle of operation, advantages and disadvantages of different types of Circuit breakers, Testing of Circuit breakers, UNIT testing, synthetic testing
SS Topic:短路试验布线。  

**UNIT – IV**  

**Protective Relaying:** 需求保护继电器，保护区域，主保护和后备保护，保护继电器的必要性，分类保护继电器。介绍数字继电器（块图）  

**Induction type relay:** 非方向性和方向性过电流继电器，IDMT和方向性特性。差动继电器——操作原理，百分比差动继电器，偏向特性，距离继电器——三步骤距离保护，阻抗继电器，阻抗继电器，Mho继电器，Buchholz继电器，负序继电器。

**SS Topics:** 微处理器为基础的过电流继电器——块图方法。  

**UNIT – V**  

**Protection Schemes:**  
发电机保护 - Merz价格保护，电动机故障，定子和转子故障，保护异常情况 - 不平衡加载，励磁丢失，过速。变压器保护 - 差动保护，差动继电器与谐波 restraint。  

**SS Topic:** 互感故障  
感应电机保护 – 保护电气故障，如相故障，接地故障，保护感应电机在异常运行条件下，如单相并联，相位反转，过载。

**Course Outcomes:**  
在课程结束时，每位学生将能够

1. 理解开关和保险丝的必要性及接地系统的意义
2. 说明断路器的原理及其类型。
3. 理解不同类型的电路断路器和继电器的构造和工作原理。
4. 区分并应用各种保护方案。
5. 识别各种保护方案的发电机和变压器。

**Mapping of POs & COs:**

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TEXT BOOKS:**


REFERENCE BOOKS:

E Books / MOOCS / NPTEL:
2. http://nptel.ac.in/downloads/108101039/

ELECTRICAL MACHINE DESIGN & CAD

Sub Code : 15EE603 Credits : 04
Hrs/Week : 3*+2+0+0 Total Hours : 39*+26

* Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites
DCSM (15EE303), TIM (15EE402)

Course Learning Objectives:
1. To Describe the design process and basic CAD practices for engineering design and drawing.
2. To Analyze the design of DC machines
3. To illustrate the Design of single phase and three phase transformer.
4. To the Analyze the design of Synchronous machines.

UNIT – I

PRINCIPLES OF ELECTRICAL MACHINE DESIGN:
Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines. 3*+1 Hours

Introduction to CAD:
Study of auto CAD graphics package. Exercises on computer aided electrical drawing - single line diagram for a typical substation. 3*+1 Hours

UNIT – II

DESIGN OF DC MACHINES: Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot
dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and poles, field windings – shunt, series and inter poles.  

UNIT – III

DESIGN OF TRANSFORMERS (Single phase and three phase): Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and cross sectional area of Primary and secondary windings, estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular).  

UNIT – IV

DESIGN OF INDUCTION MOTORS: Output equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, choice of length of the air gap. Estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring Rotor, Estimation of no load current and leakage reactance.

UNIT – V

DESIGN OF SYNCHRONOUS MACHINES: Output equation, Choice of specific loadings, short circuit ratio, design of main dimensions, armature slots and windings, slot details for the stator of salient and non- salient pole synchronous machines, design of rotor of salient pole machines, magnetic circuits, dimensions of the pole body, design of the field winding, and design of rotor of non-salient pole machine.

Course Outcomes:
At the end of the course student will be able to
1. Describe the design process and basic CAD practices for engineering design and drawing.  
2. Analyze the design of DC machines  
3. Illustrate the Design of single phase and three phase transformer.  
4. Illustrate the Design of Induction machine.  
5. Analyze the design of Synchronous machines.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TEXT BOOKS:

REFERENCE BOOKS:

POWER ELECTRONICS LABORATORY
Sub Code : 15EE604
Credits : 02
Hrs/Week : 0+0+3+0
Total Hours : 39

Course Learning Objectives:
1. To know the Static characteristics of SCR.
2. To verify the Static characteristics of MOSFET and IGBT.
3. To CR turn-on circuit using synchronized UJT relaxation oscillator.
4. To verify the SCR Digital triggering circuit for a single -phase controlled rectifier / A.C. voltage controller.
5. To verify Single -phase full-wave rectifier with R and R-L loads.

List of Experiments
1. Static characteristics of SCR.
2. Static characteristics of MOSFET and IGBT.
3. SCR turn-on circuit using synchronized UJT relaxation oscillator.
4. SCR Digital triggering circuit for a single -phase controlled rectifier / A.C. voltage controller.
6. A.C. voltage controller using TRIAC and DIAC combination connected to R and R-L loads.
7. Speed control of a separately excited D.C. motor using an IGBT/ MOSFET chopper.
8. Speed control of a stepper motor.
10. MOSFET/IGBT based single-phase full-bridge inverter connected to R load.
11. Auxiliary and LC commutation circuit.
12. DSP based speed control of motor

Course Outcomes:
At the end of the course student will be able to
1. Demonstrate the static characteristics of MOSFET, IGBT and SCR and identify different regions of operation.
3. Build AC voltage controller circuit using TRAIC DIAC combination and verify its application in speed control of IM and universal motor.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+++++++++++++++++++++++++++++++++++++++

ELECTRICAL CAD LABORATORY

Sub Code : 15EE605
Hrs/Week : 0+0+2+0
Credits : 01
Total Hours : 26

Course Learning Objectives :
1. To introduce CAD tool for drawing design diagrams of electrical machines and apparatus.
2. To understand the practical aspects of electrical machine design and verify the same.

List of Experiments

1. Single line diagram of electrical substation.
2. DC Winding Diagrams Simplex Lap and Wave windings.
3. DC Winding Diagrams Duplex Lap and Wave windings.
4. AC Winding Diagrams: Integral and Fractional slot single layer Lap and Wave windings
5. AC Winding Diagrams: Integral and Fractional slot double layer Lap and Wave windings.
6. Transformers - sectional views of single and three phase core type transformers
7. Transformers - sectional views of single and three phase shell type transformers
8. D.C. machine - sectional views of different parts: yoke, field system, armature and commutator.
9. Induction motor: sectional view
10. Synchronous machine: sectional view

Course Outcomes:
At the end of the course student will be able to
1. Use the CAD tools to draw single line diagrams of electrical substation.
2. Use the electrical CAD software to draw the DC winding diagram and AC winding diagrams
3. Use the electrical CAD software to draw the sectional views of 3 phase, single phase shell / core transformers.
4. Use the electrical CAD software to draw the sectional views of different parts of DC machine.
5. Use the electrical CAD software to draw the sectional views of different parts of Induction, synchronous machines.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

********************************************

LINEAR IC AND CONTROL SYSTEMS LABORATORY

Sub Code : 15EE606  Credits : 02
Hrs/Week : 0+0+3+0  Total Hours : 39

Course Learning Objectives:
1. To study various op-amp based circuits and their applications.
2. To understand working of Schmitt trigger, multivibrators circuit and filter using op-amp.
3. To understand voltage regulator and applications of 555 timers.
5. To understand DC and AC Servo motor characteristics and Synchro transmitter-receiver pair.
List of Experiments

   a. Inverting and Non-inverting amplifiers.
   b. Inverting and Non Inverting Zero crossing detector
   a. Differentiator
   b. Inverting Non inverting Integrators
4. Relaxation Oscillators- astable and monostable multivibrators using Op-amp
5. Precision Rectifiers-precision HWR and FWR using Op-amp, Transfer characteristics.
6. Voltage Regulators using
   a. IC 723 (high / low voltages)
   b. IC 78XX.
7. Timer IC 555 experiments: Monostable multivibrator, Astable multivibrator, Schmitt trigger
11. DC and AC Servo motor characteristics, Synchro transmitter-receiver pair.
12. Performance characteristics of P, PI, and PID controller
13. PLL characteristics, Finding Lock Range and Capture Range.

Course Outcomes:
At the end of the course student will be able to
1. Use op-amp based basic circuits for various applications.
3. Design and use voltage regulator and 555 timers.
5. Study DC and AC Servo motor characteristics and Synchro transmitter-receiver pair.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E Learning / E Books
1. IIT Bombay Linear Integrated Circuits Virtual Lab
   http://iitb.vlab.co.in/?sub=43&brch=225
   *******************
ENTRY EDGE: IMMERSIVE GROUP WORKSHOP (IGW)

Sub Code: 15EE607                                                                                       Duration: 5 Days
Timings : 9.00 AM to 12.30 PM, 1.15 PM to 4.45 PM

Module 1: Minds-on and hands-on simulation project

1. Understanding Task environment – Goals, responsibilities, Task focus
2. Working in Teams towards common goals
5 Hours

Module 2: Re-enforcement of critical individual skills and behaviours

1. Application of individual effectiveness skills in team and organizational context – improving self awareness, goal setting, time management, communication and presentation skills. 
7 Hours

Module 3: Etiquettes and Ethics

1. Professional etiquettes at workplace – dressing, telephone, e-mail, meeting and general behaviour
2. Basic honesty & respect for law / rules
3. Conflict of interest
4. Use of organizational resources
5. Misrepresentation and misappropriation
6. Intellectual property
7. Whistle blowing

7 Hours

Module 4: Interpersonal Behaviour & relationship skills

1. Establishing trust based relationships in team & organizational environment
2. Trust equation – credibility, responsiveness, integrity, self-interest

3.5 Hours

Module 5: Dealing with Conflicts

Orientation towards conflicts in team and organizational environment
1. Understanding sources of conflicts
2. Conflict resolution styles and techniques

3.5 Hours

Pedagogical tools & techniques used in the workshop

Organizational templates for simulating a organizational context- structures, units, roles and activities
Metaphoric scenarios for simulating real–life tasks and dynamics in a team/project context
LEGO™ building blocks for simulating last-mile technical activity in teams
Case studies, Role play scenarios group learning activities, observation and feedback.

Note: Evaluation is done and a grade of P (pass) or NP (not pass) is awarded

*******************************
SWITCHED MODE POWER CONVERTERS

Sub Code : 15EE611 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours : 39

Course Learning Objectives:
1. To introduce the concept of switched mode power converters.
2. To study the working of non-isolated and isolated DC-DC switching power converter.
3. To understand the working of switched mode DC-AC inverters.
4. To understand the concept of resonant converter.
5. To study various power line disturbance and power conditioners.

UNIT – I

DC-DC switched mode converter topologies: Introduction, Control of dc-dc converters. Buck, Boost, Buck-Boost, Cuk dc-dc converter topologies, Full-bridge dc-dc converter. 8 Hours

UNIT – II

DC-DC switched mode converter comparison generalized comparison between switched mode and linear dc regulator, dc-dc converter with isolation – flyback converters, other flyback converter topologies, forward converter, push-pull converter, half and full bridge converter. 8 Hours

UNIT – III

DC-AC switched mode inverters: Basic concept of switch-mode Inverters, single-phase inverter, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, ripple in the inverter output, switch utilization, problems. 8 Hours

UNIT – IV

Resonant switch converters: Classification of resonant converter, Resonant switch converter – ZCS, ZVS, ZVS-CV dc-dc converters; Resonant dc-link inverter with ZVS, problems. 7 Hours

UNIT – V

Power line disturbances, Power Conditioner and uninterruptible power supplies, solar power based bidirectional inverter- High frequency inductor and transformers design: specific inductor transformer design, Inductor and transformer design procedure. 8 Hours

Course Outcomes:

At the end of the course student will be able to
1. Illustrate the concepts of different types of DC-DC converters.
2. Compare linear and switched mode converters and understand the principle of operation of dc-dc converter with isolation.
3. Analyze and understand the concepts of switched mode inverters.
4. Illustrate the working of different resonant converter.
5. Analyze the role of power conditioners to suppress various power line disturbances and understand the working of UPS, design of magnetic components.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOKS:

***********************

RENEWABLE ENERGY SOURCES

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>15EE612</th>
<th>Credits : 03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hrs/Week</td>
<td>3+0+0+0</td>
<td>Total Hours : 39</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
1. To illustrate the principle of extraction of energy from conventional, nonconventional sources.
2. To demonstrate the working principle and applications of solar based thermal, electrical and PV systems
3. To justify the usage of energy storage techniques and Understand the process of design and implement of wind based energy conversion systems
4. To understand the process of design and implement of biomass based energy conversion systems.

UNIT – I

Energy Sources: Introduction, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Classification of Energy Resources; Conventional Energy
Resources - Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario.  


UNIT – II


Solar PV Systems – stand-alone and grid connected; Applications – Street lighting, Domestic lighting and Solar Water pumping systems.

UNIT – III


UNIT – IV


UNIT – V

Energy from Ocean: Tidal Energy – Principle of Tidal Power, Components of Tidal Power Plant (TPP), Classification of Tidal Power Plants, Estimation of Energy – Single basin and Double basin type TPP (no derivations. Simple numerical problems), Advantages and Limitation of TPP. Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation – Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC); Site-selection criteria, Biofouling, Advantages & Limitation of OTEC.

**Course Outcomes:**

At the end of the course student will be able to

1. Illustrate the principle of extraction of energy from conventional, nonconventional sources.
2. Demonstrate the working principle and applications of solar based thermal, electrical and PV systems
3. Justify the usage of energy storage techniques and Understand the process of design and implement of wind based energy conversion systems
4. Explain the process of design and implement of biomass based energy conversion systems.
5. Outline the design and implement of tidal, OTEC based energy conversion systems and comprehend the emerging technologies in the area of RES.

**Mapping of POs & COs:**

<table>
<thead>
<tr>
<th>Program Outcomes →</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TEXT BOOK :**


**REFERENCE BOOKS :**


******************
INTRODUCTION TO ASIC AND FPGA DESIGN

Sub Code : 15EE613
Credits : 03

Course Learning Objectives:
1. To study the design flow of different types of ASIC.
2. To familiarize the different types of programming technologies and logic devices.
3. To learn the architecture of different types of FPGA.
4. To gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC.
5. To analyse the synthesis, Simulation and testing of systems. To understand the design issues of SOC.
6. To know about different high performance algorithms and its applications in ASICs.

UNIT – I

UNIT - II

UNIT - III

UNIT - IV
FPGA: Field Programmable gate arrays- Logic blocks, routing architecture, Design flow technology - mapping for FPGAs, XilinxXC4000 - ALTERA's FLEX 8000/10000, ACTEL's ACT-1,2,3 and their speed performance Case studies: Altera MAX 5000 and 7000 - Altera MAX 9000 – Spartan II and Virtex II FPGAs - Apex and Cyclone FPGAs.

UNIT – V
Course Outcomes:
At the end of the course student will be able to
1. Comprehend the basics of ASIC and PLD.
2. Analyse the ASIC Physical Design
3. Analyse The Logic Synthesis, Simulation And Testing of ASIC And PLD:
4. Comprehend the architecture of different types of FPGA.
5. Analyse the design issues of SOC.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td>√</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCE BOOKS:

***************

ADVANCED CONTROL THEORY

Sub Code : 15EE614
Hrs/Week : 3+0+0+0
Credits : 03
Total Hours : 39

Prerequisites: Linear Control System (15EE503), VCTT (15EE301)

Course Learning Objectives :
1. To understand the state model, linearization of state equations.
2. To Apply state space technique for modeling of LTI systems, solve the state equation.
3. To Compute state transition matrix, the eigen values, eigen vectors.
4. To Analyze the system for controllability and observability and design the controller using pole placement techniques to ensure stability.
UNIT – I
State variable analysis & design, canonical representation and transfer function, linearization of state equations, State space representation using physical variables. State space representation using phase variables & canonical variables, Derivation of transfer function from state model, Solution of state equation.

UNIT – II
State transition matrix & its properties, computation using Laplace transformation, Cayley-Hamilton method (only computation), Eigen values, Eigen vectors, generalized Eigen vectors, diagonalization.

UNIT – III
Concept of controllability & observability, methods of determining the same. Pole placement techniques: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement.

UNIT – IV
Introduction, behavior of non-linear system, common physical non linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity, Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories by Isocline method and Delta method.

UNIT – V
Lyapunov’s stability criteria for linear as well as nonlinear systems, stability definitions, theorems, sign definiteness, direct method, second method, krasovskii’s method, variable gradient method and for linear systems for state variable models.

Course Outcomes:
At the end of the course student will be able to
1. Introduce the state model, linearization of state equations.
2. Compute state transition matrix, the eigen values, eigen vectors space technique for modeling of LTI systems, solve the state equation.
3. Analyze the system for controllability and observability and design the controller using pole placement techniques to ensure stability
4. Comprehend the behavior and stability analysis of non linear system
5. Analyse the Stability of linear and nonlinear system using Liapunov criteria.
Syllabus of V & VI Semester B.E. / Electrical & Electronics Engg.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
<th>j</th>
<th>k</th>
<th>l</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOKS:

E Books / MOOC / NPTEL:
1. http://nptel.ac.in/courses/108103007/
2. https://www.coursera.org/learn/designing-organization/lecture/Md2km/4-2-2-traditional-control-systems
3. https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x

OPERATIONS RESEARCH

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>Credits</th>
<th>Hrs/Week</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE615</td>
<td>03</td>
<td>3+0+0+0</td>
<td>39</td>
</tr>
</tbody>
</table>

Prerequisites
PTNM (15EE401)

Course Learning Objectives:
1. To understand the model and obtain solution to the Linear Programming Problems.
2. To Solve the dual of LPP and compare the results of dual and primal. Also apply replacement theory for efficient operations.
3. To Solve transportation and assignment problems and to solve game theory problems.
4. Build the network and crash it effectively and efficiently using PERT / CPM methods.
UNIT – I

**Introduction**: definition, OR models, characteristics and phases of OR.  

**Linear programming and Graphic Solution**: Linear Programming: Formulation of Two variable LPP model, Graphical solution of two variables LPP, special cases in graphic solution: multiple optimal solution, infeasibility and unboundedness, simplex method: conditions and solutions to LPP using Simplex method, Big M method, Special cases in simplex method: multiple optimal, infeasibility, unboundedness, Degeneracy, sensitivity analysis.

UNIT – II

**Duality**: Definition of the dual problem, primal to dual relationships, economic interpretation of duality.

**Replacement Theory**: Introduction, Replacement policy for equipment which deteriorates gradually, replacement of items that fail suddenly, staff replacement.

UNIT – III

**Transportation Model**: definition of transportation model, basic Feasible solution by NW Corner method, Least Cost method and MODI method, optimal solutions: stepping stone method, MODI method, the assignment model, traveling salesman problem.

UNIT – IV

**GAME THEORY**: Formulation of two - person, zero sum games, solving simple games, the Max-min min-max principles, graphical solution procedure, solving by linear programming.

UNIT – V

**PERT & CPM TECHNIQUES**: Network representation, critical path computation, construction of the time schedule, variation under probabilistic models, crashing of simple networks, PERT calculations.

**Course Outcomes:**

At the end of the course student will be able to

1. Formulate, model and obtain solution to the Linear Programming Problems.
2. Solve the dual of LPP and compare the results of dual and primal. Also apply replacement theory for efficient operations.
3. Solve transportation and assignment problems.
4. Formulate and solve game theory problems
5. Build the network and crash it effectively and efficiently using PERT / CPM methods.
Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes →</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOK:

E Books/ MOOC/ NPTEL:
2. https://www.coursera.org/learn/wharton-operations
3. http://nptel.ac.in/courses/112106134/
4. http://nptel.ac.in/courses/112106131/
5. https://onlinecourses.nptel.ac.in/noc17_mg10/preview

POWER ELECTRONICS SYSTEM DESIGN USING ICS

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>Credits</th>
<th>Hrs/Week</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15EE621</td>
<td>03</td>
<td>3+0+0+0</td>
<td>39</td>
</tr>
</tbody>
</table>

Prerequisites
PE (15EE504), LIC (15EE501)

Course Learning Objectives:
1. To understand the measurement techniques to measure various electrical parameters
2. To illustrate the working and characteristics of Switching Regulator Control Circuits
3. To understand the various Commercial PWM Control ICs and their Applications
4. To know the significance of 555 timers, PLL, ADC, DAC circuits in the implementation of different gating / power electronics circuits.
UNIT – I

**Introduction:** Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed.  

*7 Hours*

UNIT – II

**Switching Regulator Control Circuits:** Introduction, isolation techniques of switching regulator systems, PWM systems.  

*8 Hours*

UNIT – III

**Commercial PWM Control ICs and their Applications:** TL 494 PWM Control IC, UC 1840 Programmable off line PWM controller, UC 1524 PWM control IC, UC1846 current mode control IC, UC 1852 resonant mode power supply controller.  

*8 Hours*

UNIT – IV

**Switching Power Supply Ancillary, Supervisory & Peripheral Circuits and Components:** Introduction, Opto-couplers, self-biased techniques used in primary side of reference power supplies, Soft/Start in switching power supplies, current limit circuits, over voltage protection, AC line loss detection.  

*8 Hours*

UNIT – V

**Phase – Locked Loops (PLL) & Applications:** PLL Design using ICs, 555 timer & its applications, analog to digital converter using IC’s, digital to analog converters using ICs, implementation of different gating circuits.  

*8 Hours*

**Course Outcomes:**

At the end of the course student will be able to

1. Analyze measurement techniques to measure various electrical parameters
2. Illustrate the working and characteristics of Switching Regulator Control Circuits
3. Appreciate various Commercial PWM Control ICs and their Applications
4. Explain Switching Power Supply Ancillary, Supervisory & Peripheral Circuits and Components
5. Use the 555 timer, PLL, ADC, DAC circuits in the implementation of different gating / power electronics circuits.

**Mapping of POs & COs:**

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td>CO1</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO2</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO3</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCE BOOKS:

3. UNITrode application notes: http://www.smps.us/UNITrode.html

***************

OBJECT ORIENTED PROGRAMMING USING C ++

Sub Code : 15EE622 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours : 39

Prerequisites: CCP (15CS111), CCP Lab (15CS116)

Course Learning Objectives:

1. To demonstrate the concept of Object Oriented programming and its realization in C++.
2. To explain the concept of functions and classes.
3. To illustrate the concepts of objects constructors and destructors
4. To introduce the meaning of operator overloading type conversion and inheritance.

UNIT – I

Principles of Object-Oriented Programming: Review of Procedure Oriented Programming, Basic concepts of Object Oriented Programming – Object, Class, Encapsulation, Inheritance, Polymorphism; Benefits of OOPs, Applications of OOP’s. 3 Hours

The Basic Language C++: A comparison of C and C++, Structure of C++ program with Class, Preprocessor directives, C++ Statements – Input/Output, Comments, Tokens, Keywords, Identifiers, Constants, Data types – string, pointer, reference, boole, enumeration, array, complex number; typedef names, type compatibility, type conversion, qualifier – const, volatile; Operators in C++, Operator Precedence and Operator Overloading; C++ expressions – New and Delete. 5 Hours
UNIT – II

Functions in C++: Introduction, The main() function, Function prototype, Call by reference, Return by reference, Inline functions, Default arguments, const Arguments, Function Overloading, Friend and Virtual functions, pointer to functions. 4 Hours

Classes: Introduction – declaration and definition of a Class, defining member functions, C++ program with a Class, Making an outside function Inline, Nesting of member functions, Arrays within a class, Static data members, static member functions 4 Hours

UNIT – III

Objects: global & local objects, scope & lifetime, memory allocation for objects, dynamically allocated objects, pointers to objects, arrays of objects, function arguments with objects, returning objects; const member functions. 3 Hours

Constructors and Destructors: Introduction, Constructors, Parameterized Constructors, Multiple constructors in a class, Constructors with default arguments, Dynamic initialization of objects, Copy constructor, Constructing two-dimensional arrays, const Objects, Destructors. 4 Hours

UNIT – IV

Operator Overloading and Type Conversion: Introduction, Defining operator overloading, Overloading unary operators, Overloading binary operators, Overloading binary operators using Friends, Rules for overloading operators, overloading a comma operator, overloading the output operator , Type conversion. 5 Hours

Inheritance: Introduction, Defining derived classes, Single inheritance, Making a private member Inheritable, Multilevel inheritance, Multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Virtual base classes, Abstract classes. 3 Hours

UNIT – V

Pointer, Virtual Functions and Polymorphism: Introduction, Pointers, Pointers to Objects, this pointer, Pointers to derived classes, type-checking pointers, pointers to members, Virtual functions, Pure virtual functions. 4 Hours

Managing Console I/O and File I/O: C++ streams, C++ stream classes, examples of formatted and unformatted I/O operations, Classes for file stream operations, Methods of Opening and Closing a File, Examples of Opening file using constructor open(), file modes (simple programming exercises). 4 Hours

Course Outcomes:

At the end of the course student will be able to
1. Demonstrate the concept of Object Oriented programming and its realization in C++.
2. Comprehend the concept of functions and classes.
3. Illustrate the concepts of objects constructors and destructors
4. Enumerate the meaning of operator overloading type conversion and inheritance.
5. Summarize the concepts of pointers virtual functions and polymorphism and importance of managing console I/O, File I/O.
Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOKS:

E-Books / MOOC /NPTEL
2. http://nptel.ac.in/courses/106105151/
3. https://onlinecourses.nptel.ac.in/noc16_cs19/preview

********************

ARM SYSTEM ARCHITECTURE

Sub Code : 15EE623
Hrs/Week : 3+0+0+0

Credits : 03
Total Hours : 39

Prerequisites : MC (15EE403)

Course Learning Objectives :

1. To introduce the assembly instructions of ARM7TDMI processor and its internal functioning, enabling students to understand any other processor architectures at ease.
2. Provide good understanding of how coprocessors are interfaced with ARM core and how coprocessors can be programmed.
3. Provide an in-depth understanding of the Floating point representation and the VFP coprocessor implementation in particular.

4. Cover the details of cache architectures, AMBA bus, virtual memory management concepts with the detailed explanation on the Memory Management UNIT (MMU) and Memory Protection UNIT (MPU)

5. Give good overview of various peripherals used with ARM core and it basic functioning. Touch upon later versions of ARM7 processor and their features and new developments.

UNIT – I

**ARM Introduction and Pipeline structures:** Types of computer Architectures, ISA's and ARM History. Embedded System Software and Hardware, stack implementation in ARM, Endianness, and condition codes. Processor core VS CPU core, ARM7TDMI Interface signals, Memory Interface, Bus Cycle types, Register set, Operational Modes. Instruction Format, ARM Core Data Flow Model, ARM 3 stage Pipeline, ARM family attribute comparison. ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution.

8 Hours

UNIT – II


8 Hours

UNIT – III

**ARM Coprocessor Interface and VFP ARM coprocessor interface and Instructions, Coprocessor Instructions, data Processing Instruction, data transfers, register transfers. Number representations, floating point representation (IEEE754). Flynn's Taxonomy, SIMD and Vector Processors, Vector Floating Point Processor (VFP), VFP and ARM interactions, An example vector operation.

7 Hours

UNIT – IV

Paging, Segmentation. MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly coupled Memory (TCM).  

8 Hours

UNIT – V

ARM tools and Peripherals
ARM Development Environment, Arm Procedure Call Standard (APCS), Example C program. Embedded software Development, Image structure, linker inputs and outputs, memory map, application startup. AMBA Overview, Typical AMAB Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers, APB bridge. DMA, Peripherals, Programming Peripherals in ARM. ARM ISAs, ARMv5, ARMv6, ARM v7, big. little technology, ARMv8. ARM ISAs, ARMv5, ARMv6, ARM v7, big .little technology, ARMv8.  

8 Hours

Course Outcomes:

At the end of the course student will be able to
1. Comprehend ARM7TDMI assembly instructions and their formats and usage.
2. Develop ARM7 based assembly level programming skills and understand the various coprocessors interfaced in an SoC.
3. Explain the cache design, virtual memory and memory protection concepts and their implementation details in a typical SoC designs.
4. Comprehend on AMBA bus architecture, various HW peripherals in SoCs and how they can be used or to be designed.
5. Use any processor Software tool chains for embedded software solution development.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOK :

REFERENCE BOOKS :
5. Manuals and Technical Documents from the ARM Inc, web site.

E Books / MOOC / NPTEL
3. http://nptel.ac.in/courses/108102045/
4. http://nptel.ac.in/courses/117106111/

**********************

PROGRAMMABLE LOGIC CONTROLLERS

Sub Code : 15EE624     Credits : 03
Hrs/Week : 3+0+0+0     Total Hours : 39

Prerequisites : DEC (15EE305)

Course Learning Objectives :

1. To Justify the role of PLC in automation, SCADA and the hardware capabilities of PLC in industrial automation.
2. To Program a PLC using adder Diagram, Functional Block Diagram (FBD).
3. To understand the Sequential Functions Charts (SFC) and Structured Text (ST) methods incorporating internal relays.
4. To Program a PLC using shift registers, data handling instructions.

UNIT – I

INTRODUCTION: Introduction to Programmable logic controller (PLC), role in automation (SCADA), advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output UNITs, signal conditioning, remote connections, networks, processing inputs I/O addresses. 8 Hours

UNIT – II

PROGRAMMING: Ladder programming- ladder diagrams, logic functions, latching, multiple outputs, entering ladder programs, functional blocks, program examples, location of stop and emergency switches. 7 Hours

UNIT – III

PROGRAMMING LANGUAGES: Instruction list, sequential functions charts, structured text
INTERNAL RELAYS: ladder programs, battery- backed relays, one - shot operation, set and reset, master control relay, example programs, jump and call subroutines. 9 Hours

UNIT – IV

Timers and counters: Types of timers, programming timers, OFF- delay timers, pulse timers, programming examples, forms of counter, programming, up and down counting, timers with counters, sequencer. 8 Hours

UNIT – V

Shift register and data handling: shift registers, ladder programs, registers and bits, data handling, arithmetic functions, closed loop control, temperature control and bottle packing applications. 7 Hours

Note: Discussing the programming should be restricted to only one type of PLC (Mitsubishi)

Course Outcomes:

At the end of the course student will be able to
1. Justify the role of PLC in automation / SCADA and the hardware capabilities of PLC in industrial automation and identify various I/O devices and their characteristics for interfacing with PLC.
2. Program a PLC using Ladder Diagram, Functional Block Diagram (FBD).
3. Program a PLC using Instruction list (IL), Sequential Functions Charts (SFC) and Structured Text (ST) methods incorporating internal relays.
4. Incorporating timers /counters to program a PLC
5. Program a PLC using shift registers, data handling instructions, Comprehend the real world industrial applications of PLC using ladder diagram and instruction list.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>H</td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCE BOOKS:

E Books / MOOC/ NPTEL
4. http://nptel.ac.in/courses/112102011/
5. http://nptel.ac.in/courses/112103174/

************************

ILLUMINATION TECHNOLOGY

Sub Code : 15EE625 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours : 39

Course Learning Objectives:

1. To understand the importance of Light- Eye & Vision in designing luminaries
2. To Comprehend the Propagation of light & photometric UNITs
3. To Demonstrate the process of Production of radiation and their characteristics
4. To Enumerate the principle of Artificial light sources.
5. To Design the objectives and methods for Interior lighting.

UNIT – I

Light- Eye & Vision: Electromagnetic spectrum- Visible spectrum- Structure of the eye-
Retina- Rodes & Cones- Distribution & functions of rods & cones-Photoscopic, scotoscopic & mesopic visions- Purkinje shift color-vision, vision functions – accommodation, adaptation & Convergence- luminance contrast & color contrasts- Metamerism. 7 Hours

UNIT – II

Inter relation between the various photometric quantities –Luminous efficacy, spectral eye sensitivity Curve-Light Watt-Brightness-Luminous Existence-Radiometric quantities &UNITs-point by point method of luminance calculations –simple problems. 8 Hours
UNIT – III


UNIT – IV

Artificial light sources: construction- principle of operation- luminous efficiency- lamp life & color characteristics of incandescence, Tungsten halogen, fluorescent, High pressure mercury vapor, High Pressure sodium vapor and metal halide lamps- new trends in lamp technology. 7 Hours

UNIT – V

Interior lighting design: Lighting design objectives-safely and health performance-appearance & comport lighting design flow chart.
Lighting for commercial and public buildings such as offices, hotels teaching establishments and hospital lighting
Lighting for industrial buildings, low & high bay area’s general lighting designs.
Lighting for display-Shops & super markets, art galleries, museum lighting, lumen method of calculations-simple problems. 9 Hours

Course Outcomes:

At the end of the course student will be able to
1. Explain the importance of Light- Eye & Vision in designing luminaries
2. Comprehend the Propagation of light & photometric UNITs
3. Demonstrate the process of Production of radiation and their characteristics
4. Enumerate the principle of Artificial light sources.
5. Explain the Design objective and methods for Interior lighting.

Mapping of POs & COs:

<table>
<thead>
<tr>
<th>Program Outcomes→</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
<th>j</th>
<th>k</th>
<th>l</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Course Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOK :
REFERENCE BOOKS:

*************************

EMPLOYABILITY SKILL DEVELOPMENT

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>Credits: Nil (MLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15IL001/002</td>
<td></td>
</tr>
<tr>
<td>Hrs/Week</td>
<td>0+1+0+0</td>
</tr>
<tr>
<td>Total Hours</td>
<td>12</td>
</tr>
</tbody>
</table>

UNIT – I

Analytical Aptitude Skill: concept of analytical skill, definition-logical thinking and testing of Analytical Aptitude

UNIT – II

Quantitative Aptitude skill-Concept-definition-Preliminary requirement for development of quantitative skill- testing of quantitative skill.

UNIT – III

Verbal and ability skill – Knowledge and Vocabulary and grammar-comprehension-Verbal Reasoning skill

REFERENCE BOOKS:

Examination pattern:

This course is a mandatory learning course without credit. Continuous internal examination (CIE) consists of 2 internal exams (20 marks each) and tasks (10 marks). There is no semester end examination (SEE). The student will be awarded PP or NP grade as per autonomous regulations.

*************************