V Semester

Engineering Management & Entrepreneurship			Semester	V
Course and Course Code	HSMS	IBEE501	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:

After completion of the course, the students will be able to

- Understand basic skills of Management
- Understand the need for Entrepreneurs and their skills
- Identify the Management functions and Social responsibilities.
- Understand the identification of Business, drafting the Business plan and sources of funding.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
- Topics will be introduced in multiple representations.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

MODULE – 1

Management: Nature and Functions of Management – Importance, Definition, Management Functions, Levels of Management, Roles of Manager, Managerial Skills, Management & Administration, Management as a Science, Art & Profession (Selected topics of Chapter 1, Text 1).

Planning: Planning-Nature, Importance, Types, Steps and Limitations of Planning; Decision Making – Meaning, Types and Steps in Decision Making(Text 1).

Teaching-Learning Process	Chalk and talk method, YouTube Videos, Power Point Presentation.
RBT Levels	L2, L3

MODULE – 2

Organizing and Staffing: Organization-Meaning, Characteristics, Process of Organizing, Principles of Organizing, Span of Management (meaning and importance only), Departmentalization-Process Departmentalization, Purpose Departmentalization ,Committees– Meaning, Types of Committees.

Staffing-Need and Importance, Recruitment and Selection Process.

Directing and Controlling: Meaning and Requirements of Effective Direction, Giving Orders; Motivation-Nature of Motivation, Motivation Theories (Maslow's Need-Hierarchy Theory and Herzberg's Two Factor Theory); Communication – Meaning, Importance and Purposes of Communication (Text 1).

Teaching-Learning Process	Chalk and talk method, YouTube Videos, Power Point Presentation.
RBT Levels	L2, L3

MODULE – 3

Leadership-Meaning, Characteristics, Behavioural Approach of Leadership; Coordination-Meaning, Types, Techniques of Coordination; Controlling – Meaning, Need for Control System, Benefits of Control, Essentials of Effective Control System, Steps in Control Process (Text 1).

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance (Text 1).

Teaching-Learning Process	Chalk and talk method, YouTube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3

MODULE – 4

Entrepreneurship: Introduction, Evolution of the concept of Entrepreneurship, Entrepreneurship today, Types of Entrepreneurs, Entrepreneurship, Entrepreneurial competencies, Capacity Building for Entrepreneurs.

Identification of Business Opportunities: Introduction, Mobility of Entrepreneurs, Business opportunities in India, Models for opportunity Evaluation.

Teaching-Learning Process	Chalk and talk method, YouTube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3

MODULE – 5

Business plans: Introduction, purpose of a Business plan, contents of a Business plan, presenting a Business plan, why do some Business plan fail? Procedure for setting up an Enterprise.

Institutions supporting Business opportunities: Central level institutions- National Board for micro, small & medium Enterprises(NBMSME),MSME-DO, National Small Industries Corporation. State level institutions- state Directorate Industries and commerce, District Industries Centres, state financial Corporations, State Industrial Development Corporation(SIDC), State Industrial Area Development Board (SIADB). Other Institutions - NABARD, Technical consultancy organisation (TCO), Small Industries Development Bank of India(SIDBI), Export Promotion Councils, Non governmental Organisations.

Teaching-Learning Process	Chalk and talk method, YouTube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3

Course outcomes (Course Skill Set):

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

1) Understand the fundamental concepts of Management and its functions.
2) Understand the different functions to be performed by managers/Entrepreneur.
3) Understand the social responsibilities of a Business.
4) Understand the Concepts of Entrepreneurship and to identify Business opportunities.
5) Understand the components in developing a business plan and awareness about various sources of funding and Institutions supporting Entrepreneur.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/

course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1) Principles of Management – P.C Tripathi, P.N Reddy, McGraw Hill Education, 6th Edition, 2017. ISBN-13:978-93-5260-535-4.
2) Entrepreneurship Development Small Business Enterprises- Poornima M Charantimath,2nd Edition, Pearson Education 2018, ISBN 978-81-317-6226-4.

Reference Books

1) Essentials of Management: An International, Innovation and Leadership perspective by Harold Koontz, Heinz Weihrich McGraw Hill Education, 10th Edition 2016. ISBN- 978-93-392-2286-4.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/110107094
- https://nptel.ac.in/courses/110106141
- https://nptel.ac.in/courses/122106031

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes,
- Assignments,
- Seminars

SIGNALS AND DSP			
IPCC Course Code	**BEE 502**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

1. To explain basic signals, their classification, basic operations on signals, sampling of analog signals, and the properties of the systems.
2. To explain the convolution of signals in continuous and discrete time domain and the properties of impulse response representation.
3. To explain the computation of Discrete Fourier Transform of a sequence by direct method, Linear transformation Method and using Fast Fourier Transformation Algorithms.
4. To explain design of IIR all pole analog filters and transform them into digital filter using Impulse Invariant and Bilinear transformation Techniques and to obtain their Realization.
5. To explain design of FIR filters using Window Method and Frequency Sampling Method and to obtain their Realization.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teachingmethods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinkingskills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the studentsto come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve

the students' understanding.

MODULE-1

Signals, systems and signal processing, classification of signals, Basic Operations on Signals, Basic Elementary Signals, properties of systems. concept of frequency in continuous and Discrete time signals, sampling of analog signals, the sampling theorem , quantization of continuous amplitude and sinusoidal signals , coding of quantized samples, digital to analog conversion,

Time-domain representations for LTI systems: Convolution, impulse response representation, Convolution Sum and Convolution Integral, properties of impulse response representation, solution of difference equations.

Teaching-Learning Process	Chalk and Board, Power Point Presentation, You Tube Videos.

MODULE-2	
Discrete Fourier Transforms (DFT): Introduction to DFT, definition of DFT and its inverse, matrix relation to find DFT and IDFT ,Properties of DFT, linearity, circular time shift, circular frequency shift, circular folding, symmetry of : real valued sequences, real even and odd sequences, DFT of complex conjugate sequence, multiplication of two DFTs- the circular convolution, Parseval's theorem, circular correlation, Digital linear filtering using DFT. Signal segmentation , overlap-save and overlap-add method.	
Teaching-Learning Process	Chalk and Board, Power Point Presentation, You Tube Videos.
MODULE-3	
Fast-Fourier-Transform (FFT) algorithms: Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms)., speed improvement factor, Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and Decimation-in-frequency algorithms , calculation of DFT when N is not a power of 2.	
Teaching-Learning Process	Chalk and Board, Power Point Presentation, You Tube Videos.
MODULE-4	
IIR filter design: Classification of analog filters, generation of Butterworth polynomials, frequency transformations. Design of Butterworth filters, low pass, high pass, band pass and band stop filters, Generation of Chebyshev polynomials, design of Chebyshev filters, design of Butterworth and Chebyshev filters using bilinear transformation and Impulse invariance method, representation of IIR filters using direct form one and two, series form and parallel form.	
Teaching-Learning Process	Chalk and Board, Power Point Presentation, You Tube Videos.
MODULE 5	
FIR filter design: Introduction to FIR filters, symmetriv and antisymmetric FIR filters, design of linear phase FIR filters using - Rectangular, Bartlett, Hamming, Hanning and Blackman windows, design of FIR differentiators and Hilbert transformers, FIR filter design using frequency sampling Technique. Representation of FIR filters using direct form and lattice structure.	
Teaching-Learning Process	Chalk and Board, Power Point Presentation, You Tube Videos.

Sl. NO	**Experiments**
1	Verification of Sampling Theorem in time and frequency domains
2	Generation of different signals in both continuous and discrete time domains
3	To perform basic operations on given sequences- Signal folding, evaluation of even and odd signals
4	Evaluation of impulse response of a system.

5.	Solution of a difference equation.
6.	Evaluation of linear convolution and circular convolution of given sequences
7	Computation of N- point DFT and IDFT of a given sequence by use of (a) Defining equation; (b) FFT method
8	Evaluation of circular convolution of two sequences using DFT and IDFT approach.
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters).
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions.
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.
12	Realization of IIR and FIR filters.
13	**Following experiments to be done using DSP Kit:** a)Obtain the linear convolution of two sequences b)Compare circular convolution of two sequences c)To find N –point DFT of given sequence d)To find impulse response of first and second order system e)Generation of sine wave and standard test signals

Course outcomes (Course Skill Set):

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

(1)Discuss classification and basic operations that can be performed on both continuous and discrete time signals and to understand sampling theorem.

(2)Evaluate Discrete Fourier Transform of a sequence , to understand the various properties of DFT and signal segmentation using overlap and overlap add method.

(3)Evaluate Discrete Fourier Transform of a sequence using decimation in time and decimation in frequency methods.

(4) To design Butterworth and Chebyshev IIR digital filters and to represent the filters using different methods and to represent IIR filter using different methods.

(5)To design FIR filters using windows method and frequency sampling method and to represent FIR filters using direct method and lattice method.

Text Books/Reference Books:

1.Introduction to Digital Signal Processing, Jhonny R. Jhonson, Pearson 1 st Edition, 2016.

2.Digital Signal Processing – Principles, Algorithms, and Applications,Jhon G. Proakis Dimitris G. Manolakis, Pearson, 4 th Edition, 2007.

3. Digital Signal Processing, A.NagoorKani, McGraw Hill, 2nd Edition, 2012.

4. Digital Signal Processing, Shaila D. Apte,Wiley, 2nd Edition, 2009.

5. Digital Signal Processing, Ashok Amberdar, Cengage, 1st Edition, 2007.
6. Digital Signal Processing, Tarun Kumar Rawat, Oxford, 1st Edition, 2015.

Web links and Video Lectures (e-Resources):
1. http://www.freebookcentre.net/Electronics/DSP-Books
2. https://www.electronicsforu.com/special/cool-stuff-misc/8-free-digital-signal-processing-ebooks

MOOCs
1. https://nptel.ac.in/courses/117102060

Assessment Details (both CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)
- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are 25 marks and that for the practical component is 25 marks.
- 25 marks for the theory component are split into 15 marks for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and 10 marks for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for 25 marks).
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC
- 15 marks for the conduction of the experiment and preparation of laboratory record, and 10 marks for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test (duration 02/03 hours) after completion of all the experiments shall be conducted for 50 marks and scaled down to 10 marks.
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 25 marks.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC
Theory SEE will be conducted by University as per the scheduled timetable, with common question

papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Power Electronics		Semester	V
Course Code	BEE503	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1 Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2 Lectures with discussions, question and answer sessions.
3 Informal quizzes.
4 Use of Video/Animation to explain functioning of various concepts.
5 Encourage collaborative (Group Learning) Learning in the class.
6 Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
7 Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
8 Introduce Topics in manifold representations.
9 Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
10 Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction: Applications of Power Electronics, Ideal Characteristics of switches Characteristics of practical devices; Specifications of Switches, control characteristics of power devices, Types of Power Electronic Circuits, Peripheral Effects, Intelligent Modules.

Power Diodes: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Freewheeling diodes**,** Freewheeling diodes with RL load.

Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL load, Single-Phase Full-Wave Rectifiers with R load, Single-Phase Full-Wave Rectifier with RL Load.

Module-2

Power Transistors: Introduction, Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, Power MOSFETs – Steady State Characteristics, Switching Characteristics, IGBTs; BJT Base Drive, MOSFET Gate Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers.

Module-3

Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn- On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dt Protection, dv/dt Protection, Thyristor Firing Circuits, Unijunction Transistor.

Module-4

Controlled Rectifiers: Introduction, Single phase half wave circuit with RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual Converters, Principle of operation of Three- Phase duel Converters.

AC Voltage Controllers: Introduction, Principle of phase control & Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers.

Module-5

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

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

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

Textbook

1 Power Electronics: Circuits Devices and Applications, Mohammad H Rashid, Pearson 4th Edition, 2014.

Reference Books

1 Power Electronics, P.S. Bimbhra, Khanna Publishers, 5th Edition, 2012.
2 Power Electronics: Converters, Applications and Design, Ned Mohan et al, Wiley 3rd Edition, 2014.
3 Power Electronics, Daniel W Hart, McGraw Hill, 1st Edition, 2011.
4 Elements of Power Electronics, Philip T Krein, Oxford, Indian Edition, 2008.

Web links and Video Lectures (e-Resources):

• .
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning •

Power Electronics Laboratory		Semester	V
Course Code	BEEL504	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		

Course objectives:

1) To conduct experiments on semiconductor devices to obtain their static characteristics. To study different methods of triggering the SCR
2) To study the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
3) To control the speed of a DC motor, universal motor and stepper motors.
4) To study single phase full bridge inverter connected to resistive load.

Sl.NO	Experiments
1	Static Characteristics of SCR.
2	Static Characteristics of MOSFET and IGBT.
3	Characteristic of TRIAC.
4	SCR turn on circuit using synchronized UJT relaxation oscillator.
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.
6	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without freewheeling diode.
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.
8	Speed control of DC motor using single phase semi converter.
9	Speed control of stepper motor.
10	Speed control of universal motor using ac voltage regulator.
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.
12	Single phase MOSFET/IGBT based PWM inverter.

Course outcomes (Course Skill Set):

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

1 Obtain static characteristics of semiconductor devices to discuss their performance.
2 Trigger the SCR by different methods
3 Verify the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
4 Control the speed of a DC motor, universal motor and stepper motors.
5 Verify the performance of single phase full bridge inverter connected to resistive load.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

High Voltage Engineering		Semester	V
Course Code	BEE515A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

1. To understand the conduction and breakdown mechanism in gases, liquid and solid dielectrics.
2. To know about generation of high voltages and currents and their measurement.
3. To understand the various types of over voltages phenomenon and protection methods.
4. To discuss non-destructive testing of materials and electric apparatus.
5. To discuss high-voltage testing of electrical equipment

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.

Discuss how every concept can be applied to the real world-and when that's possible, it helps improve the students' understanding..

Module-1

Introduction: Electric field stress, gas, liquid, solid and composite dielectrics.

Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Process – types of collision, Mobility of ions and electrons. Ionization Processes- Ionization by collision. Townsend's Current Growth Equation--Current Growth in the Presence of primary and Secondary Processes, Townsend's Criterion for Breakdown, Breakdown in Electronegative Gases, Time Lags for Breakdown, Paschen's Law, Corona Discharges.

Conduction and Breakdown in Liquid Dielectrics: purification of liquid dielectrics, Breakdown in Liquid dielectrics. - Suspended particle, bubble and stressed oil volume mechanism.

Conduction and Breakdown in Solid Dielectrics: Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.

Module-2

Generation of High Direct Current Voltages: Voltage Doubler circuit, Voltage multiplier circuit- Cockcroft Walton circuit, Ripple and voltage drop in multiplier circuit. Vandegraaff generator.

Generation of High Alternating Voltages: Cascade transformers, Resonant transformers, Tesla coil.

Generation of Impulse Voltages and currents: Standard impulse wave, Circuit for producing impulse waves- Analysis of impulse generator RLC circuit, Wave shape control, Marx circuit , Generation of impulse current: standard impulse current wave ,Circuit for producing impulse current wave.

Module-3

Measurement of High DC Voltages and Currents: Measurement of High DC Voltages – Series Resistance micro ammeter, Resistance potential divider, Generating voltmeter.

Measurement of High AC voltages- Series impedance voltmeter, Series capacitance voltmeter, Capacitance potential dividers, Capacitance voltage transformers. Electrostatic voltmeter, series capacitance peak voltmeter (chubb-Fortscue method), Spark gaps for measurement of High dc, ac and Impulse voltages - Spark gap measurements, Factors influencing the spark over voltage of sphere gaps.

Measurement of Impulse Voltages – Resistance potential dividers, capacitance voltage dividers, Mixed R-C potential dividers Peak reading voltmeters for impulse voltages.

Measurement of High DC, AC and impulse Currents - Hall generator, Resistive shunt, Rogowski coils and Magnetic links.

Module-4

Natural Causes for Over voltages

Lightning phenomenon –Charge formation in the clouds, Mechanism of lightning strokes, Mathematical model for lighting, Over voltages due to indirect stroke.

Power frequency Overvoltage – Sudden load rejection, Ferranti effect. Control of over voltages due to switching.

Protection of transmission lines against over voltages- Using shielded or ground wires, Ground rods and counter poise wires, Surge arresters -Protector tubes, Nonlinear element surge arrestor.

Module-5

Non-Destructive Testing of Materials and Electrical Apparatus

Power frequency measurements- Schering bridge for audio frequency, transformer ratio arm bridge. Partial discharge measurements- straight discharge detection, Balance detection.

High Voltage Testing of Electrical Apparatus-Testing of insulators, bushings, circuit breakers, cables. Testing of transformers- Impulse test, Tests on surge arrestors.

Course outcome (Course Skill Set)

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

1. Have detailed knowledge of conduction and breakdown phenomenon in gases, liquids and solid dielectrics.
2. Ability to design and simulate the generation of high voltages and currents
3. Ability to design and analyze the measurement techniques for high voltages and currents
4. Summarize overvoltage phenomenon and protection of electric power systems.
5. Explain non-destructive testing of materials and high-voltage testing of electric apparatus

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Textbook:

1. High Voltage Engineering M.S. Naidu, V.Kamaraju McGraw Hill 5th Edition, 2013.
2. High Voltage Engineering Wadhwa C.L. New Age International 3rd Edition, 2012

Reference Books:

1. High Voltage Engineering Fundamentals E. Kuffel, W.S. Zaengl, J. Kuffel Newnes 2nd Edition, 2000
2. High-Voltage Test and Measuring Techniques Wolfgang Hauschild • Eberhard Lemke Springer 1st Edition2014
3. High Voltage Engineering Farouk A.M. Rizk CRC Press 1st Edition2014

Web links and Video Lectures (e-Resources):

www.nptel.ac.in
Link of Journals, Magazines, websites and Research Papers
http://digital-library.theiet.org/content/journals/hve 2
https://archive.nptel.ac.in/courses/108/104/108104048

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Quizzes, Seminars,
Visit transformer manufacturing industry,
Testing laboratories - CPRI.

Power Electronics for Renewable Energy Systems		Semester	V
Course Code	BEE515B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To appreciate the advantages of renewable energy sources over conventional energy sources
- To study solar PV systems – stand alone and grid connected - and their maximum power tracking methods
- To study wind energy systems and the electrical machines (DFIG) used in WES
- To study MPPT methods and in WES.
- To study other renewable energy sources- biomass, fuel cells and ocean energy
- To study power electronics converters for PV and WES

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and board
2. PPT

Module-1

Review of Power semiconductor devices: Thyristors, GTOs, POWER MOSFETS, IGBTs, MCTs.

Classification of Energy Sources – Importance of Non-conventional energy sources, Advantages and disadvantages of conventional energy sources, Impacts of renewable energy generation on the environment.

Module-2

Solar PV Systems: Solar PV characteristics, Grid requirement for PV, Power electronic converters used for solar PV, Control techniques, 12-pulse rectifier circuits - high voltage 12-pulse rectifier, and high current 12- pulse rectifier, MPPT, Grid connected and Islanding mode, Grid synchronization, PLLs, battery charging in PV systems.

Module-3

Wind Energy Conversion: Wind Turbine characteristics, Grid requirement for Wind, PMSM and DFIG for wind generators, Power electronic converters for PMSM and DFIG rotor side and stator side converters, Control techniques, MPPT, Grid connected and Islanding mode of operation.

Module-4

Qualitative study of other renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, Fuel cells: Operating principles and characteristics

Module-5

Power Converters and their control in AC microgrids: Microgrid architecture, AC, Microgrid, AC/DC microgrid, Schematics of solar PV and WT powered DC and DC/AC microgrids, Grid-forming, grid-feeding, current source based grid supporting and voltage source based

grid supporting converters. Grid feeding converters- Droop control with dominant inductive and dominant resistive grids, overview of virtual impedance control, overview of hierarchical control.

Course outcome (Course Skill Set)

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

1. Describe WES and PV systems
2. Develop MPPT algorithms for PV systems and WES.
3. Design converters for PVS and SES
4. Describe biomass, fuel cells and oceanic energy sources
5. Discuss grid connection issues of renewable energy sources.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

1. Fang Lin Luo, Hong Ye, "Advanced DC/AC Inverters: Applications in Renewable

@#@

Energy" CRC Press.
2. Sudipta Chakraborty, Marcelo G. Simões, William E. Kramer, "Power Electronics for Renewable and Distributed Energy Systems" Springer 2013.

Journal Publications

a. "An Overview of Power Electronics Applications in Fuel Cell Systems: DC and AC Converters" Hindawi Publishing Corporation, Scientific World Journal, Volume 2014, Article ID 103709, 9 pageshttp://dx.doi.org/10.1155/2014/103709
b. J. Rocabert, A. Luna, F. Blaabjerg and P. Rodríguez, "Control of Power Converters in AC Microgrids," in *IEEE Transactions on Power Electronics*, vol. 27, no. 11, pp. 4734-4749, Nov. 2012, doi: 10.1109/TPEL.2012.21993
c. S. P. Bihari *et al.*, "A Comprehensive Review of Microgrid Control Mechanism and Impact Assessment for Hybrid Renewable Energy Integration," in *IEEE Access*, vol. 9, pp. 88942-88958, 2021, doi: 10.1109/ACCESS.2021.3090266.

Web links and Video Lectures (e-Resources):

- www.nptel.ac.in
- https://www.youtube.com/watch?v=FvOAZC8Urcs

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

-

ELECTRIC VEHIVLE FUNDAMENTALS		Semester	V
Course Code	BEE515C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To understand the concept of electric vehicles.
- To study about the motors & drives for electric vehicles.
- To understand the electronics and sensors in electric vehicles.
- To understand the concept of hybrid vehicles.
- To study about fuel cell for electric vehicles.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1 Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2 Lectures with discussions, question and answer sessions.
3 Informal quizzes.
4 Use of Video/Animation to explain functioning of various concepts.
5 Encourage collaborative (Group Learning) Learning in the class.
6 Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
7 Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
8 Introduce Topics in manifold representations.
9 Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.

Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction to Electric Vehicles : Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.

Module-2

Electric Vehicle Motors: Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor, Design.

Module-3

Electronics and Sensor-less control in EV: Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self drive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.

Module-4
Hybrid Vehicles: Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.
Module-5
Fuel Cells for Electric vehicles: Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Describe about working principle of electric vehicles. 2. Explain the construction and working principle of various motors used in electric vehicles. 3. Understand about working principle of electronics and sensor less control in electric vehicles. 4. Describe the different types and working principle of hybrid vehicles. 5. Illustrate the various types and working principle of fuel cells.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

1. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.
2. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/106/108106170/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

-

FUNDAMENTALS OF VLSI DESIGN		Semester	V
Course Code	BEE515D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

Impart knowledge of mass transistors theory and CMOS technology.

- Understand the basic electrical properties of mass and BICMOS circuits.
- Cultivate the concept of subsystem design and layout processes .
- Understand the concept of design process computational elements.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1 Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2 Lectures with discussions, question and answer sessions.
3 Informal quizzes.
4 Use of Video/Animation to explain functioning of various concepts.
5 Encourage collaborative (Group Learning) Learning in the class.
6 Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
7 Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
8 Introduce Topics in manifold representations.
9 Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
10. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Moore's law, speed power performance, nMOS fabrication, CMOS fabrication: n-well, p-well processes, BiCMOS, Comparison of bipolar and CMOS.

Basic Electrical Properties of MOS And BiCMOS Circuits: Drain to source current versus voltage characteristics, threshold voltage, transconductance.

Module-2

Basic Electrical Properties of MOS And BiCMOS Circuits: nMOS inverter, Determination of pull up to pull downratio, nMOS inverter driven through one or more pass transistors, alternative forms of pull up, CMOS inverter,BiCMOS inverters, latch up.

Basic Circuit Concepts: Sheet resistance, area capacitance calculation, Delay unit, inverter delay, estimation ofCMOS inverter delay, driving of large capacitance loads, super buffers, BiCMOS drivers.

Module-3

MOS and BiCMOS Circuit Design Processes: MOS layers, stick diagrams, nMOS design style, CMOS design style, design rules and layout, λ - based design.

Scaling of MOS Circuits: scaling factors for device parameters, limitations of scaling.

Module-4
Subsystem Design and Layout-1 : Switch logic pass transistor, Gate logic inverter, NAND gates, NOR gates,pseudo nMOS, Dynamic CMOS, example of structured design, Parity generator, Bus arbitration, multiplexers, logicfunction block, code converter. **Subsystem Design and Layout-2 :** Clocked sequential circuits, dynamic shift registers, bus lines, subsystem designprocesses, General considerations, 4-bit arithmetic processes, 4-bit shifter.
Module-5
Design Process-Computational Elements: Regularity, design of ALU subsystem, ALU using adders, carry lookahead adders, Multipliers, serial parallel multipliers, Braun array, Bough – Wooley multiplier. **Memory, Registerand Aspects of Timing:** Three Transistor Dynamic RAM cell, Dynamic memory cell, Pseudo- Static RAM, JK Flipflop,D Flip-flop circuits, RAM arrays, practical aspects and testability: Some thoughts of performance, optimizationand CAD tools for design and simulation
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Identify the CMOS layout levels, and the design layers used in the process sequence. 2. Describe the general steps required for processing of CMOS integrated circuits. 3. Design static CMOS combinational and sequential logic at the transistor level. 4. Demonstrate different logic styles such as complementary CMOS logic, pass-transistor Logic, dynamic logic, etc. 5. Interpret the need for testability and testing methods in VLSI

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Basic VLSI Design -3rd Edition, Douglas A Pucknell, KamaranEshraghian, Prentice Hall of India publication, 2005.
2. CMOS Digital Integrated Circuits, Analysis And Design, 3rd Edition, Sung – Mo (Steve) Kang, Yusuf Leblbici, Tata McGraw Hill, 2002.
3. VLSI Technology - S.M. Sze, 2nd edition Tata McGraw Hill, 2003.

Web links and Video Lectures (e-Resources):

. .VTU e-shikshanaprogramme VTU Edu-sat programmes • https://nptel.ac.in/courses/117101058
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Quizzes • Assignment • Seminars

POWER SYSTEM ANALYSIS I		Semester	VI
Course Code	**BEE601**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- To introduce the per unit system and explain its advantages and computation and explain the concept of single line (one line) diagram and its implementation in problems.
- To explain analysis of three phase symmetrical faults on synchronous machine and simple power systems.
- To explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits.
- To explain the concept of sequence impedance and sequence networks in three phase unbalanced circuits.
- To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system.

Teaching-Learning Process (General Instructions)
These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecture method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain function for various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which foster students 'Analytical skills, develop design thinking skill such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world-and when that's possible, it will improve the students understanding.

MODULE-1

Representation of Power System Components: Introduction, Single-phase Representation of Balanced Three Phase Networks, One-Line Diagram and Impedance or Reactance Diagram, Per Unit (PU)System, Steady State Model of Synchronous Machine, Power Transformer, Transmission of Electrical Power, Representation of Loads.

MODULE-2

Symmetrical Fault Analysis: Introduction, Transient on transmission Line, Short Circuit of a Synchronous Machine (On No Load), Short Circuit of a Loaded Synchronous Machine, Illustrative simple examples on power systems. Selection of Circuit Breakers.
MODULE-3
Symmetrical Components: Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta Transformers, Sequence Impedances of Transmission Lines, Sequence Impedances and Sequence Network of Power System, Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines, Sequence Impedances Transformers and Construction of Sequence Networks of a Power System.
MODULE-4
Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground(LG)Fault, Line-To-Line(LL)Fault, Double Line-To-Ground(LLG)Fault, Open Conductor Faults.
MODULE-5
Power System Stability: Introduction, Dynamics of a Synchronous Machine, Review of Power Angle Equation, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Write a program to draw power angle curves for salient and non-salient pole synchronous machines, reluctance power, excitation, EMF and regulation.
2	Write a program to calculate Sag of a transmission line for i)Poles at equal height ii)Poles at unequal height
3	Write a program to determine the efficiency, Regulation, ABCD parameters for short and long transmission line and verify AD-BC=1.
4	Write a program to determine the efficiency, Regulation and ABCD parameters for medium transmission line for i) Π- configuration ii) T- Configuration and verify AD-BC=1.
5	Write a program to calculate sequence components of line voltages given the unbalanced phase voltages.
6	Write a program to calculate the sequence components of line currents, given the unbalanced phase currents in a three phase i) 3-wire system ii) 4 wire system.
7	Determination of fault currents and voltages in a single transmission line for i) Single Line to Ground Fault. ii)Line to Line Fault iii) Double Line to Ground Fault Using suitable simulating software package.
8	Determination of fault currents and voltages in a single transmission line for Three phase Fault Using suitable simulating software package.
9	Write a program to obtain critical disruptive voltage for various atmospheric and conductor conditions.
10	Write a program to evaluate transient stability of single machine connected to infinite bus.

Course outcomes (Course Skill Set):

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

1. Model the power system components &construct per unit impedance diagram of power system.
2. Analyse three phase symmetrical faults on power system.
3. Compute unbalanced phasors in terms of sequence components and vice versa, also develop sequence networks.
4. Analyse various unsymmetrical faults on power system.
5. Examine dynamics of synchronous machine and determine the power system stability.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

The IPCC means the practical portion integrated with the theory of the course. CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.

CIE for the theory component of the IPCC

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.

- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Suggested Learning Resources:

Textbook

1. Modern Power System, D. P. Kothari, McGraw Hill, 4th Edition, 2011.

Reference Books

1. Elements of Power System, William D. Stevenson Jr, McGraw Hill, 4th Edition, 1982.
2. Power System Analysis and Design, J. Duncan Gloveretal, Cengage, 4th Edition, 2008.
3. Power System Analysis, Hadi Sadat, McGraw Hill,1stEdition,2002.

Web links and Video Lectures (e-Resources):
https://nptel.ac.in/courses/108104051

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Activity Based Learning, Quizzes, Seminars.

B.E ELECTRICALANDELECTRONICSENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER-VI

CONTROLSYSTEMS (PCC)

Subject Code	BEE602	IA Marks	50
Number of Lecture Hours/Week	03:02:00:00	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	50

Credits-04

Course objectives:

(1)To analyze and model electrical and mechanical system using analogous systems.
(2) To formulate transfer functions using block diagram and signal flow graphs.
(3) To analyze the transient and steady state time response.
(4) To illustrate the performance of a given system in time and frequency domains, stability analysis using Root locus and Bode plots.
(5) To discuss stability analysis using Nyquist plots, Design controller and compensator for a given specification.

Module-1

Introduction to control systems: Introduction, classification of control systems.
Mathematical models of physical systems: Modeling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for Deriving transfer functions, servomotors, gear trains.

Revised Bloom's Taxonomy Level	L_1–Remembering, L_2–Understanding, L_3–Applying, L_4–Analysing.

Module-2

Block diagram: Elements of Block Diagram, Block diagram of a closed loop system, Block diagram reduction techniques, procedure for block diagram reduction to find transfer function. Numerical.
Signal flow graphs: Construction of signal flow graphs, definition of some important terms, basic properties of signal flow graph, Mason's gain formula, signal flow graph algebra, Numerical

Revised Bloom's Taxonomy Level	L_1–Remembering,L_2–Understanding,L_3–Applying,L_4–Analysing.

Module-3

Time Domain Analysis: Introduction**,** Standard test signals, time response of first order systems, time response of second order systems, Time response specifications, steady state errors and error constants, Approximation of higher order systems and step response of second order systems with zero's.
Routh Stability criterion: BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis. Numerical

RevisedBloom's TaxonomyLevel	L_2–Understanding,L_3–Applying,L_4–Analysing,L_5–Evaluating.

Module-4

Root locus : Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. Numerical
Frequency domain analysis: Introduction, Co-relation between time and frequencyresponse– 2^{nd}order systems only.
Bode plots: Basic factors G(iw)/H(jw), General procedure for constructing Bode plots, computation of gain margin and phase margin. Numerical

Revised Bloom's Taxonomy Level	L_1–Remembering, L_2–Understanding, L_3–Applying, L_4–Analysing.

Module-5

Control Systems – Compensators and Controllers: Introduction, Phase-Lead Compensator, Phase-Lag Compensator, Lead-Lag Compensator. Proportional controller, Derivative controller, Integral controller, PD Controller, PI Controller, PID Controller,
State space model- Concepts of State, State variable and State model, State Model for linear continuous time systems, Transfer Function from State Space Model, State Transition Matrix and its Properties, Solution of state equation.

RevisedBloom's TaxonomyLevel	L_1–Remembering, L_2–Understanding, L_3–Applying, L_4–Analysing.

Course out comes:

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

1. Analyze and model electrical and mechanical system using analogous.
2. Formulate transfer functions using block diagram and signal flow graphs.
3. Analyze the stability of control system, ability to determine transient and steady state time response.
4. Illustrate the performance of a given system in time and frequency domains, stability analysis using Root locus and Bode plots.
5. Discuss controllers and various compensators.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Modern Tool Usage, Life-long learning.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 20 marks.
- There will be two full questions from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1	Control Systems	Anand Kumar	PHI	2nd Edition,2014

Reference Books

1	Automatic Control Systems	Farid Golnaraghi, Benjamin C.Kuo	Wiley	9th Edition,2010
2	Control Systems Engineering	Norman S.Nise	Wiley	4th Edition,2004
3	Modern Control Systems	Richard C D orfetal	Pearson	11th Edition,2008
4	Control Systems, Principles and Design	M.Gopal	McGawHill	4th Edition,2012
5	Control Systems Engineering	S.Salivahananetal	Pearson	1st Edition,2015

Medium Voltage Substation Design		Semester	VI
Course Code	BEE613A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- Explain the concepts behind substation engineering and design.
- Demonstrate how to prepare and read SLD for substation.
- Demonstrate how to size and select LV and HV equipment's for power distribution, protection and switchgear.
- Formulate and analyze erection key diagram, layout preparation and necessary sectional clearance in substation installation.
- Assess multi-disciplinary approach in substation erection.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and Talk,
2. Discussion and Q & A
3. Quizzes
4. Videos and E –resources
5. Substation Visits etc

Module-1

Substation Basics

Substation Introduction and Classifications, Busbar Types in Outdoor Switchyard, Outdoor /Indoor Substation - Auxiliary Equipment in a Substation, Standards and Practices, Factors Influencing Substation Design -Different factors like Altitude, Ambient Temperature etc. with animation, Selection of Dielectric Strength for Electrical Equipment with animation on creepage distance, Testing of Electrical Equipment, Concepts of Single Line Diagram.

Module-2

Transformers and Switchgears

Classification of Transformers with a practical overview, Transformer Percentage Impedance and Losses, Construction including busbar arrangement and safety features, Classifications of MV Switchgear and Key Design Parameters, MV Switchgear Construction, LV Compartment, Security Interlocks & General Arrangement, Control Circuit Components - Control Relays, Time Delay Relays & Latched Relays), Control Scheme Basics, Trip Lockout, TCS and Anti-pumping Circuits, Logic Schemes.

Module-3

Protection and Station Auxiliary equipment and Digital Substation

Power System Network, Protection System, Overcurrent and Earth Fault, Overcurrent and Earth Fault – Coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Transformer Protection, Familiarization of NUMERICAL Relays, Diesel Generator System, Instrument transformers (CT), Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Evolution of Substation Automation, Communication System Fundamentals, Substation Automation System: DI, DO, AI, AO, Remote Terminal Unit –

RTU, Substation Automation Requirements – Time Synchronizing, HMI, SCADA.

Module-4

Cabling System & Illumination, Outdoor SS Layout engineering, Erection Key Diagram, Earthing and Lighting Protection

LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable Glands, Lugs, and their Accessories, Types and Classifications of Surge Arresters, Characteristics of Surge Arresters, Illumination System Design, Equipment Layout engineering aspects for Outdoor Substation and related calculations and guide lines, Basics of Outdoor Air Insulated Substation up to 33 kV - Statutory Clearances, Practical approach to Cable routing layout for Outdoor S/S, Practical approach to Erection Key Diagram (EKD) for outdoor switchyard, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Lightning Protection.

Module-5

MV substation Civil design, Fire Protection, HVAC, Maintenance and Safety

Transformer Foundation, Fire Wall, and Fire Rated Doors, Civil & Structural Engineering - MV SS, Fire Detection & Alarm System and Fire Suppression System, Heating, Ventilation and Air-conditioning (HVAC) for Substation, Need for Maintenance of a Substation & schedule, Electrical Safety Rules, Standard Operating Procedures.

Course outcome (Course Skill Set)

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

1. Explain the key concepts of design, construction, operation, and maintenance of electrical substations.
2. Develop design calculations in substation engineering such as earth-mat, lightning protection, earthing, lighting, and cable sizing.
3. Develop design calculation for sizing of power transformers, diesel generator.
4. Select LV and HV equipment's in substation for power distribution, protection, and switchgear.
5. Explain Electrical Safety Rules, SOPs.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

1. Partap Singh Satnam, P.V. Gupta, "Sub-station Design and Equipment", Dhanpat Rai Publications, 1 st Edition, 2013
2. Sunil S. Rao, "Switchgear Protection and Power Systems (Theory, Practice & Solved Problems)", Khanna Publications, 14th Edition, 2019.
3. Electrical substation and engineering & practice by S. Rao, Khanna Publishers 2015
4. McDonald John D, "Electric Power Substations Engineering," CRC Press, 3 rd. Edition, 2012

Web links and Video Lectures (e-Resources):

• .
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning •

EMBEDDED SYSTEM DESIGN		Semester	VI
Course Code	**BEE613B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

To teach students

- Introductory topics of Embedded System design
- Characteristics & attributes of Embedded System
- Introduction of Embedded System Software and Hardware development
- RTOS based Embedded system design

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

. These are sample Strategies, which teacher can use to accelerate the attainment of the various course
outcomes and make Teaching –Learning more effective

1. Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various analog and digital circuits.
3. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
4. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
5. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

Module-1

Introduction: Embedded Systems and general purpose computer systems, history, classifications, applications and purpose of embedded systems (Chapter 1 – Text 1)
Core of Embedded Systems : Microprocessors and microcontrollers, RISC and CISC controllers, Big endian and Little endian processors, Application specific ICs, Programmable logic devices, COTS, sensors and actuators, communication interface, embedded firmware, other system components, PCB and passive components (Chapter 2 – Text 1)

Module-2

Characteristics and quality attributes of embedded systems: Characteristics, Operational and nonoperational quality attributes, application specific embedded system - washing machine, domain specific – automotive (Chapter 3 & 4 – Text 1)

Module-3

Hardware Software Co design and Program Modelling : Fundamental issues in Hardware Software Co-design, Computational models in Embedded System Design (Chapter 7 – Text 1: 7.1, 7.2)
Embedded Hardware Design and Development: Analog Electronic Components, Digital Electronic Components, VLSI & Integrated Circuit Design, Electronic Design Automation Tools (Chapter 8 – Text 1: 8.1, 8.2, 8.3, 8.4)

Module-4

Embedded Firmware Design and Development: Embedded Firmware Design Approaches, Embedded Firmware Development Languages (Chapter 9 – Text 1: 9.1, 9.2)
Embedded System Development Environments: Types of files generated on cross compilation (only explanation – programming codes need not be dealt), disassemble/decompliler, Simulators, Emulators and Debugging (Chapter 13 – Text 1: 13.2, 13.3,13.4)

Module-5

Real-time Operating System(RTOS) based Embedded System Design: Operating System basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling (Chapter 10 – Text 1: 10.1 to 10.5)

Course outcome (Course Skill Set)

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

1. Explain characteristics of Embedded System design
2. Acquire knowledge about basic concepts of circuit emulators, debugging and RTOS
3. Analyse embedded system software and hardware requirements
4. Develop programming skills in embedded systems for various applications
5. Design basic embedded system for real time applications

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1.Shibu K V, "Introduction to Embedded Systems", Second Edition, McGraw Hill Education

Web links and Video Lectures (e-Resources):
. NPTL Lectures: https://nptel.ac.in/courses/108102045 • Embedded Systems, IIT Delhi, Prof. Santanu Chaudhary
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning To design a simple Embedded System like simple remote ・ To demonstrate simple microcontroller based experiments like LED interfacing, LCD interfacing, DAC etc

FACTS AND HVDC TRANSMISSION		Semester	VI
Course Code	BEE613C	CIE Marks	50
Teaching Hours/Week(L:T:P:S)	(3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

FACTS Concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What Limits the Loading Capability? Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Brief Description and Definitions of FACTS Controllers, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.

Module-2

Static Shunt Compensators: Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability. Methods of Controllable Var Generation –Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC).Operation of Single Phase TSC – TSR. Switching Converter Type Var Generators, Basic Operating Principles, Basic Control Approaches.

Static VAR Compensators: SVC and STATCOM, the Regulation Slope. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time.
Module-3
Static Series Compensators: Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static synchronous Series Compensator, Transmitted Power Versus Transmission Angle Characteristic.
Module-4
Development of HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects. Power Conversion: 3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter.
Module-5
Control of HVDC Converter and System: Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.

Course outcome(Course Skill Set)

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

1. Explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
2. Describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
3. Describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
4. Explain advantages of HVDC power transmission, overview and organization of HVDC system.
5. Explain converter control for HVDC systems, commutation failure, control.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- *There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.*
- *Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks*
- *Any two assignment methods mentioned in the22OB2.4,if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)*
- *The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.*

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).

1. *The question paper will have ten questions. Each question is set for 20 marks.*
2. *There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.*
3. *The students have to answer 5 full questions, selecting one full question from each module.*
4. *Marks scored shall be proportionally reduced to50 marks.*

Suggested Learning Resources:

Books

1. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems Narain G Hingorani, Laszlo Gyugyi, Wiley 1st Edition, 2000
2. HVDC Transmission: Power Conversion Applications in Power Systems, Chan-Ki Kim et al, Wiley, 1st Edition, 2009
3. Thyristor Based FACTS Controllers for Electrical Transmission Systems , R. Mohan Mathur, Rajiv K. Varma, Wiley, 1st Edition, 2002

Web links and Video Lectures (e-Resources):

- Courses available through NPTEL. -website: nptel.ac.in

Activity Based Learning (Suggested Activities in Class)/Practical Based learning

- *Quiz*
- *Group discussion*

Electric Motor and Drive Systems for Electric Vehicles		Semester	VI
Course Code	BEE613D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

Course Objectives :The objective of this course is to make the student

1. Understand the concept of electric vehicles technology
2. Gain knowledge on power requirement of EV
3. Know the performance and control of various motors for EVs

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.

Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction -History of Electric and Hybrid Electric Vehicles.

Vehicle Fundamentals-General Description of Vehicle Movement, Power Train Tractive Effort and Vehicle Speed.

Vehicle Performance –Maximum Speed of a Vehicle , Gradeability, Acceleration Performance ,Braking Performance , Braking Force , Braking Distribution on Front and Rear Axles

Module-2

Electric Vehicles:

Configurations of Electric Vehicles, Performance of Electric Vehicles , Traction Motor Characteristics, Tractive Effort and Transmission Requirement , Vehicle Performance , Energy Consumption.

Module-3

DC Motor Drives:

Operating principle, Speed characteristics of DC motors, Combined Armature Voltage and Field Control, Chopper Control of DC Motors.

Control Methods- Two-Quadrant Control **-**Single Chopper with a Reverse Switch, Class C Two-Quadrant Chopper, Four-Quadrant control.

Module-4

Induction Motor Drives:

Basic Operation Principles of Induction Motors , Steady-State Performance Constant v/f Control, Power Electronic Control.

Field Orientation Control(FOC): Principles of FOC.

Control methods- Direction Rotor Flux control, Indirect Rotor Flux control, Voltage Source Inverter control - Voltage Control, Current Control.

Module-5

BLDC Motor Drives:

BLDC Machine Construction and Classification, Performance Analysis, Control of BLDC Motor Drives.

Control Techniques - Methods Using Observers, Methods Using Back EMF Sensing.

Switched Reluctance Motor Drives (SRM)-Basic Magnetic Structure, Torque Production,

Methods of Control -Phase Flux Linkage Method, Mutually Induced Voltage Method, Observer-Based Method, Self-Tuning Using an Artificial Neural Network.

Course outcome (Course Skill Set)

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

1.Explain the Fundamental and Performance of EV

2. Understand the Characteristics of motor control and energy consumption for EV operation

3.Analyse the Power electronics and sensors in DC motor electric vehicles.

4. Design and Analysethe induction motor drives and discuss methods for controlling them.

5. Comprehend the construction, working principle and controlof BLDC and SRM motors.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Text Books

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles.
Fundamentals, Theory, and Design by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, CRC Press, 2004.
1. Electric and Hybrid Vehicles Design Fundamentals Third Edition Iqbal Husain, CRC Press

Reference Books:

1. Hybrid ElectricVehicles, Principles And ApplicationsWith Practical Perspectives by Chris Mi , M. Abul Masrur, David Wenzhong Gao John Wiley & Sons, 2011.
2 Electric and Hybrid Vehicles, .T. Denton, Routledge, 2016.
3. Permanent Magnet Synchronous and Brushless DC Motor Drives , R Krishnan, CRC Press
4. Switched Reluctance Motor Drives, Berker B., James W. J. & A. Emadi, CRC Press

Web links and Video Lectures (e-Resources):

NPTEL courses – eMobility and Electric Vehicle Engineering https://archive.nptel.ac.in/courses/108/106/108106182
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning Quizzes, Seminars, visit EV manufacturing industry

Utilization of Electric Power		Semester	VI
Course Code	**BEE654A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1 Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2 Use of Video/Animation to explain functioning of various concepts.
3 Encourage collaborative (Group Learning) Learning in the class.
4 Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5 Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6 Introduce Topics in manifold representations.
7 Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8 Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Heating and welding: Electric Heating, Resistance ovens, Radiant Heating, Induction Heating, High frequency Eddy Current Heating, Dielectric Heating, The Arc Furnace, Heating of Buildings, Air – Conditioning, ElectricWelding, Modern Welding Techniques.

Electrolytic Electro – Metallurgical Process: Ionization, Faraday's Laws of Electrolysis, Definitions, Extraction of Metals, Refining of Metals, Electro Deposition.

Module-2

Illumination: Introduction, Radiant Energy, Definitions, Laws of Illumination, Polar Curves, Photometry,Measurement of Mean Spherical Candle Power by Integrating Sphere, Illumination Photometer, Energy Radiation and luminous Efficiency, electric Lamps, Cold Cathode Lamp, Lighting Fittings, Illumination for Different Purposes, Requirements of Good Lighting.

Module-3

Electric Traction Speed - Time Curves and Mechanics of Train Movement: Introduction, Systems of Traction, Systems of electric Traction, Speed - Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion.

Motors for Electric traction: Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors(Series Type) are used to drive a Motor Car, Tractive Effort and Horse Power, AC Series Motor, Three Phase Induction Motor.

Control of motors: Control of DC Motors, Tapped Field Control or Control by Field Weakening, MultipleUnit Control, Control of Single Phase Motors, Control of Three Phase Motors.

Module-4
Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes. **Electric Traction Systems and Power Supply:** System of Electric Traction AC Electrification, Transmission Lines to Sub - Stations, Sub – Stations, Feeding and Distribution System of AC Traction Feeding and Distribution System for DC Tramways, Electrolysis by Currents through Earth, Negative Booster, System of Current Collection, Trolley Wires. **Trams, Trolley Buses and Diesel – Electric Traction:** Tramways, The Trolley – Bus, Diesel Electric Traction.
Module-5
Electric Vehicles: Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving, Energy Consumption. **Hybrid Electric Vehicles:** Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains.
Course outcome (Course Skill Set) At the end of the course the student will be able to : 1. Discuss different methods of electric heating & welding. 2. Discuss the laws of electrolysis, extraction, refining of metals and electro deposition process. 3. Discuss the laws of illumination, different types of lamps, lighting schemes and design of lighting systems. Analyze systems of electric traction, speed time curves and mechanics of train movement. 4. Explain the motors used for electric traction, their control & braking and power supply system used for electric traction.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

Textbooks

1. A Text Book on Power System Engineering, A. Chakrabarti et al, Dhanpat Rai and Co, 2nd Edition, 2010.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design, (Chapters 04and 05 for module 5), Mehrdad Ehsani et al, CRC Press, 1st Edition, 2005.

Reference Books

1. Utilization, Generation and Conservation of Electrical Energy, Sunil S Rao, Khanna Publishers, 1st Edition,2011.
2. Utilization of Electric Power and Electric Traction, G.C. Garg, Khanna Publishers, 9th Edition, 2014.

Web links and Video Lectures (e-Resources):

- .

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

-

Technologies of Renewable Energy Sources		Semester	VI
Course Code	**BEE654B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

(1) To discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
(2) To explain sun – earth geometric relationship, Earth – Sun Angles and their Relationships.
(3) To discuss about solar energy reaching the Earth's surface and solar thermal energy applications.To discuss types of solar collectors, their configurations and their applications.
(4) To explain the components of a solar cell system, equivalent circuit of a solar cell, its characteristicsand applications.
(5) To discuss benefits of hydrogen energy, production of hydrogen energy, storage its advantages and disadvantages.
(6) To discuss wind turbines, wind resources, site selection for wind turbine.
(7) To discuss geothermal systems, their classification and geothermal based electric power generation (9To discuss waste recovery management systems, advantages and disadvantages.
(8) To discuss biomass composition, production, types of biomass gasifiers, properties of producer gas benefits.
(9) To discuss tidal energy resources, energy availability, power generation.
(10) To explain motion in the sea wave, power associated with sea wave and energy availability and the devicesfor harnessing wave energy.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1 Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2 Use of Video/Animation to explain functioning of various concepts.
3 Encourage collaborative (Group Learning) Learning in the class.
4 Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5 Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6 Introduce Topics in manifold representations.
7 Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8 Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles andtheir Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications.

Module-2

Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond.

Solar Cells: Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic panels (series and parallel arrays).

Module-3
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy. **Wind Energy:** Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. **Geothermal Energy:** Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects. **Solid waste and Agricultural Refuse:** Waste is Wealth, Key Issues, Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste, Recycling of Plastics.
Module-4
Biomass Energy: Biomass Production, Energy Plantation, Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Gasifier Biomass Feed Characteristics, Applications of Biomass Gasifier, Cooling and Cleaning of Gasifiers. **Biogas Energy:** Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefitsof Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and theirCharacteristics. **Tidal Energy:** Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy.
Module-5
Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. **Ocean Thermal Energy:** Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC.
Course outcome (Course Skill Set) At the end of the course the student will be able to : 1. Discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy. Outline energy from sun, energy reaching the Earth's surface and solar thermal energy applications. 2. Discuss types of solar collectors, their configurations, solar cell system, its characteristics and their applications. 3. Explain generation of energy from hydrogen, wind, geothermal system, solid waste and agriculture refuse. 4. Discuss production of energy from biomass, biogas. 5. Summarize tidal energy resources, sea wave energy and ocean thermal energy.
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

Textbook

1. Nonconventional Energy Resources, Shobh Nath Singh, Pearson, 1st Edition, 2015.

Reference Books

1. Nonconventional Energy Resources, B.H. Khan, McGraw Hill, 3rd Edition.
2. Renewable Energy; Power for a sustainable Future, Godfrey Boyle, Oxford, 3rd Edition, 2012.
3. Renewable Energy Sources: Their Impact on global Warming and Pollution, Tasneem Abbasi S.A. Abbasi, PHI,1st Edition, 2011.

Web links and Video Lectures (e-Resources):

- .

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

-

Industrial Servo Control Systems		Semester	VI
Course Code	**BEE654C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

(1) To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
(2) To discuss system analogs and vectors, with a review of differential equations.
(3) To discuss the concept of transfer functions for the representation of differential equations.
(4) To discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
(5) To represent servo drive components by their transfer function, to combine the servo drive building blocks intosystem block diagrams.
(6) To determine the frequency response techniques for proper servo compensation.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1 Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2 Use of Video/Animation to explain functioning of various concepts.
3 Encourage collaborative (Group Learning) Learning in the class.
4 Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5 Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.
6 Introduce Topics in manifold representations.
7 Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8 Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Servos: Introduction, Benefits of Servo Systems, Types of Servos - Evolution of Servo Drives, Classification of Drives, Components of Servos - Hydraulic/Electric Circuit Equations, Actuators- Electric, Actuators-Hydraulic,Amplifiers-Electric,Amplifiers-Hydraulic,Transducers (Feedback).

Module-2

Machine Servo Drives: Types of Drives, Feed Drive Performance.
Troubleshooting Techniques: Techniques by Drive, Problems: Their Causes and Cures.
Machine Feed Drives: Advances in Technology, Parameters for making Application Choices.
Application of Industrial Servo Drives: Introduction, Physical System Analogs, Quantities and Vectors, Differential Equations for Physical Systems, Electric Servo Motor Transfer Functions and Time Constants, Transport Lag Transfer Function, Hydraulic Servo Motor Characteristics, General Transfer Characteristics

Module-3

Generalized Control Theory: Servo Block Diagrams, Frequency-Response Characteristics and Construction of Approximate (Bode) Frequency Charts, Nichols Charts, Servo Analysis Techniques, Servo Compensation.
Indexes of Performance: Definition of Indexes of Performance for Servo Drives, Indexes of Performance for Electric and Hydraulic Drives.

Module-4

Performance Criteria: Percent Regulation, Servo System Responses.
Servo Plant Compensation Techniques: Dead-Zone Nonlinearity, Change-in-Gain Nonlinearity, Structural Resonances, Frequency Selective Feedback, Feed forward Control. Machine Considerations: Machine feed drive Considerations, Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives.

Module-5
Machine Considerations: Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed Considerations, Drive Ratio Considerations, Drive Thrust/Torque And Friction Considerations, Drive Duty Cycles.
Course outcome (Course Skill Set) 1. Explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers,feedback transducers, performance, and troubleshooting techniques. 2. Discuss system analogs, vectors and transfer functions of differential equations. 3. Discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors. 4. Represent servo drive components by their transfer function, to combine the servo drive building blocksinto system block diagrams.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

Textbook

1. Industrial Servo Control Systems Fundamentals and Applications, George W. Younkin, Marcel Dekker, 1stEdition, 2003.

Reference Books

1. Servo Motors and Industrial Control Theory, Riazollah Firoozian, Springer, 2nd Edition, 2014.
2. DC SERVOS Application and Design with MATLAB, Stephen M. Tobin, CRC, 1st Edition, 2011.

Web links and Video Lectures (e-Resources):

- .

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

-

SEMICONDUCTOR DEVICES		Semester	VI
Course Code	BEE654D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

Courseobjectives:

1)To learn basics of various types of power electronic devices
2)To study Snubber circuits for the protection of power semiconductor devices.
3)To learn gate and base drive circuits for power semiconductor devices
4) To develop a heat sink to control the temperature rise of semiconductor devices
5)Learn to design magnetic components inductors and transformers used in the power electronic circuits

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

. These are sample Strategies, which teacher can use to accelerate the attainment of the various course
outcomes and make Teaching –Learning more effective

1. Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various analog and digital circuits.
3. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
4. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
5. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

Module-1

Power Electronics: Introduction, Converter Classification, Power Electronics Concepts, Electronic Switches, Switch Selection, Spice, PSpice and Capture, Representation of switches in Pspice -The Voltage-Controlled Switch, Transistors, Diodes and Thyristors (SCRs).

Power Computations: Introduction, Power and Energy, Inductors and Capacitors, Energy Recovery, Effective Values, Apparent Power and Power Factor, Power Computations for Sinusoidal AC Circuits, Power Computations for Nonsinusoidal Periodic Waveforms, Power Computations Using Pspice.

Basic Semiconductor Physics: Introduction, Conduction Processes in Semiconductors pn Junctions, Charge Control Description of pn-Junction Operation, Avalanche Breakdown

Module-2

Power Diodes: Introduction, Basic Structure and I – V characteristics, Breakdown Voltage Considerations, On –State Losses, Switching Characteristics, Schottky Diodes.
Bipolar Junction Transistors: Introduction, Vertical Power Transistor Structures, Z-V Characteristics, Physics of BJT Operation, Switching Characteristics, Breakdown Voltages, Second Breakdown, On-State Losses, Safe Operating areas.
Power MOSFETs : Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Operating Limitations and Safe Operating Areas

Module-3

Thyristors: Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Methods of Improving di/dt and dv/dt Ratings.
Gate Turn-Off Thyristors: Introduction, Basic Structure and Z-V Characteristics,
Physics of Turn-Off Operation, GTO Switching Characteristics, Overcurrent Protection of GTOs.
Insulated Gate Bipolar Transistors: Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Latchup in IGBTs, Switching Characteristics, Device Limits and SOAs.
Emerging Devices and Circuits: Introduction, Power Junction Field Effect Transistors, Field-Controlled Thyristor, JFET-Based Devices versus Other Power Devices, MOS-Controlled Thyristors, Power Integrated Circuits, New Semiconductor Materials for Power Devices

Module-4

Snubber Circuits: Function and Types of Snubber Circuits, Diode Snubbers, Snubber Circuits for Thyristors, Need for Snubbers with Transistors, Turn-Off Snubber, Overvoltage Snubber, Turn-On Snubber, Snubbers for Bridge Circuit Configurations, GTO Snubber Considerations.
Gate and Base Drive Circuits: Preliminary Design Considerations, dc-Coupled Drive Circuits, Electrically Isolated Drive Circuits, Cascode-Connected Drive Circuits, Thyristor Drive Circuits, Power Device Protection in Drive Circuits, Circuit Layout Considerations

Module-5

Component Temperature Control and Heat Sinks: Control of Semiconductor Device Temperatures, Heat Transfer by Conduction, Heat sinks, Heat Transfer by Radiation and Convection.
Design of Magnetic Components: Magnetic Materials and Cores, Copper Windings, Thermal Considerations, Analysis of a Specific Inductor Design, Inductor Design Procedures, Analysis of a Specific Transformer Design, Eddy Currents, Transformer Leakage Inductance, Transformer Design Procedure, Comparison of Transformer and Inductor Sizes

Course outcome (Course Skill Set)

At the end of the course the student will be able to:
1) Discuss power electronic concepts, electronic switches and semiconductor physics.
2) Explain representation of switches in P-spice and power computations.
3) Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; power diodes, power BJT, power MOSFET.
4) Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; thyristors, power IGBT, power FET

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Power Electronics, Daniel W Hart, McGraw Hill.
2. Power Electronics Converters, Applications, and Design, Ned Mohan et al, Wiley, 3rd Edition, 2014.
3. Semiconductor Device Modeling with Spice, G. Massobrio, P. Antognetti, McGraw-Hill, 2nd Edition, 2010.
4. Power Semiconductor Devices, B. JayantBaliga, Springer, 2008.
5. Power Electronics Principles and Applications, Joseph Vithayathil, McGraw-Hill, 2011.

Web links and Video Lectures (e-Resources):

. Youtube videos NPTEL lecturers
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning Seminars Quiz Assignments

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VI

CONTROL SYSTEM LABORATORY

Course Code	**BEEL606**	CIE Marks	50
Number of Practical Hours/Week(L:T:P)	0:2:2	SEE Marks	50
Credits	01	Exam Hours	03

Course Learning Objectives:

- To draw the speed torque characteristics of AC and DC servo motor.
- To determine the time and frequency reposes of a given second order system using discrete components.
- To design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
- To study the feedback control system and to study the effect of P, PI, PD andPID controller and Lead compensator on the step response of the system.
- To simulate and write a script files to plot root locus, bode plot, to study the stability of the system

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

Note:

Sl.	Description	Experiment numbers
1	Perform experiments using suitable components/equipment's	1 & 2
2	Perform experiments using suitable components/equipment's and verify the results using standard simulation package	3,4,5,6 and 7
3	Perform simulation only using standard package	8,9,10 and 11

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

- Utilize software package and discrete components in assessing the time and frequency domain response of a given second order system.
- Design, analyze and simulate Lead, Lag and Lag – Lead compensators for given specifications.
- Determine the performance characteristics of ac and DC servomotors and synchro-transmitter receiver pair used in control systems.
- Simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
- Develop a script files to plot Root locus, Bode plot and Nyquist plot to study the stability of

Conduct of Practical Examination:

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

Energy Management in Electric Vehicles		Semester	VI
Course Code	BEE657A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01
Examination type (SEE)	MCQ		

Course objectives:

- To provide a comprehensive understanding of energy management principles and strategies specific to electric vehicles.
- To familiarize students with the various components and systems involved in energy management in electric vehicles.
- To equip students with the knowledge and skills to apply optimization techniques for efficient energy management in electric vehicles.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Interactive Lectures: Conduct interactive lectures where the instructor presents the theoretical concepts, principles, and case studies related to energy management in electric vehicles.
2. Case Studies and Projects: Assign case studies and projects that require students to apply the concepts and strategies learned in class to real-world scenarios.
3. Guest Lectures and Industry Visits: Invite guest speakers from the industry or research organizations who are experts in the field of energy management in electric vehicles.

Module-1

Introduction to Electric Vehicles and Energy Management Overview of electric vehicles (EVs) - Types of EVs (Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles); Advantages and challenges of EVs. Introduction to energy management in EVs - Importance of energy management; Key objectives of energy management in EVs. Electric vehicle components and systems- Battery systems; Power electronics and motor drive systems; Regenerative braking systems; Energy storage and management systems

Module-2

Fundamentals of Energy Management Energy storage technologies for EVs - Lithium-ion batteries; Solid-state batteries; Supercapacitors; Fuel cells. Battery charging and discharging techniques - Charging infrastructure for EVs; Charging modes (AC and DC charging); Fast charging vs. slow charging; Battery management systems (BMS). Energy efficiency and energy loss analysis - Losses in power electronics and motor drive systems; Losses in battery systems; Factors affecting energy efficiency in EVs.

Module-3

Advanced Energy Management Strategies State-of-charge (SoC) estimation and management - SoC estimation techniques (Coulomb counting, Kalman filtering, etc.); SoC balancing techniques; Impact of SoC on battery life and performance. Power management strategies - Optimal power allocation between different vehicle systems; Dynamic power allocation based on driving conditions; Power flow control in EVs. Regenerative braking and energy recovery - Principles of regenerative braking; Control strategies for regenerative braking; Energy recovery and utilization.

Module-4
Optimization Techniques for Energy Management Optimization models for energy management - Linear programming and nonlinear optimization; Model predictive control (MPC) for energy management; Genetic algorithms and other heuristic optimization techniques. Intelligent energy management systems - Artificial intelligence (AI) and machine learning techniques for energy management; Reinforcement learning-based energy management; Data-driven approaches for energy optimization. Realtime energy management algorithms - Real-time optimization algorithms for energy allocation; Adaptive control strategies for energy management; Integration of energy management with navigation systems.
Module-5
Case Studies and Applications Energy management in electric buses and fleet management - Challenges and strategies for energy management in public transportation; Fleet management and scheduling optimization. Energy management in electric vehicles charging infrastructure - Smart charging stations and grid integration; Demand-side management and load balancing. Emerging trends and future directions in energy management - Wireless charging technologies; Vehicle-to-vehicle (V2V) communication for energy optimization; Advanced energy storage and conversion technologies.
Course outcome (Course Skill Set) At the end of the course the student will be able to: 1. Understand and analyse the energy storage technologies used in electric vehicles. 2. Understand the design and implementation of energy management strategies for electric vehicles, considering factors such as battery charging, power allocation and regenerative braking. 3. Understand optimization techniques and intelligent algorithms to optimize energy management in electric vehicles, considering real-time constraints and factors such as driving conditions and energy efficiency goals.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. "Electric Vehicle Technology" by H. C. Rai
2. "Electric Vehicle Energy Management System for Efficiency Optimization" by Jingang Han, Linlin Tan, and Xinbo Ruan
3. "Advanced Electric Drive Vehicles" edited by Ali Emadi
4. "Electric Vehicle Technology Explained" by James Larminie and John Lowry

Web links and Video Lectures (e-Resources):

- makes.mindmatrix.io

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

-

Simulation and Control of Power Electronics Circuits		Semester	
Course Code	BEEL657B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-1	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	practical/Viva-Voce		

Course objectives:

- To be able to simulate any DC-DC converter and observe the performance under various test conditions
- To be able to simulate single phase and three phase DC –AC converters and observe the performance under various test conditions
- To be able to simulate uncontrolled, half controlled and fully controlled AC-DC converters and observe the performance under various test conditions

Sl.NO	Experiments
1	(a)Simulate a single phase half wave diode bridge rectifier. Input 100V, 50 Hz. AC supply. At the out put, resistance of 50 ohms. (b)Simulate a single phase full wave diode bridge rectifier. Input 100V, 50 Hz. AC supply. At the out put, resistance of 50 ohms.
2	(a) Simulate a single phase half controlled full wave rectifier. Input 100V, 50 Hz. AC supply. At the out put, resistance of 50 ohms. (b) Simulate a single phase fully controlled full wave rectifier. Input 100V, 50 Hz. AC supply. At the out put, resistance of 50 ohms.
3	Simulate a buck converter with 20 V DC input, and regulate the output at 10 V by implementing a PI controller for closed loop operation. The out put power to vary from 10 W to 20 W. Ensure that voltage ripple is limited to 1%.
4	Simulate a boost converter with 20 V DC input, and regulate the output at 35 V by implementing a PI controller for closed loop operation. The out put power to vary from 30W to 60 W. Ensure that voltage ripple is limited to 1%
5	Simulate a single phase AC voltage controller using a triac with 100V ,50 Hz. AC supply for an RL load of 10 oms and 2 mH.
6	Simulate a three phase inverter with 180 degree conduction mode with DC input of 100V and a star connected balanced resistive of 40 ohms each. Use IGBT for inverter.
7	Simulate a single phase SPWM inverter with 50V DC input with modulation indices of 0.5, 0.6 and 0.8. connect a resistance of 25 ohms at the output of inverter. Use power Mosfets for inverter.
8	Simulate a three phase inverter with 120 degree mode of conduction. Take input DC voltage of 100V and three phase star connected balanced resistive load of 50 ohms each.
	Demonstration Experiments (For CIE)
9	In expt. 8. connect suitable LC filter at the output to obtain a sinusoidal output with THD of less than 8 %.

10	Simulate a three phase SPWM inverter with 50V DC input with modulation indices of 0.5, 0.6 and 0.8. connect a star connected resistances of 25 ohms each at the output of the inverter. Use power Mosfets for inverter.
11	Simulate a three phase, 5 level, neutral point clamped (NPC) inverter. Input DC voltage is 100V. The inverter output is connected to a balanced 3 phase resistive load of 40 Ohms each.
12	Simulate a forward converter with input DC voltage of 30 V. Take transformer ratio of 1.5:1. Observe the output voltages for duty cycles of 0.4, 0.6 and 0.8. Ensure that the output voltage ripple is less than 0.5 V. The load resistance is 10 Ohms.

Course outcomes (Course Skill Set):

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

- Simulate any given power electronic circuit and evaluate its performance under different test conditions and also observe the performance for different values of passive filtering elements used in the converter.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the

academic calendar of the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

https://in.mathworks.com/solutions/electrification/power-electronics-simulation.html

- - This provides design examples for power electronics simulation using MATLAB

Energy Audit Project		Semester	
Course Code	**BxxLxxx**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)		SEE Marks	50
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

- Along with prescribed hours of teaching –learning process, provide opportunity to perform the experiments/programmes at their own time, at their own pace, at any place as per their convenience and repeat any number of times to understand the concept.
- Provide unhindered access to perform whenever the students wish.
- Vary different parameters to study the behaviour of the circuit without the risk of damaging equipment / device or injuring themselves.
- To carryout Energy Audit for an industry, business establishment, organization and its computation using
- Scilab Software and proposing possible remedial measures to reduce the energy consumption.

Students shall select real time project/audit with the approval of the guide. The following shall be considered by the students and guide while auditing.

(1) Building and Utility Data Analysis: The main purpose of this step is to evaluate the characteristics of the energy systems and the patterns of energy use for the premises considered. The premises characteristics can be collected from the architectural/ mechanical/electrical drawings and/or from consultation/discussions with premises operators. The energy use patterns can be obtained from a compilation of utility bills over a period.

(2) Walk-Through Survey: This step should identify potential energy savings measures. The results of this stepare important since they determine if the building warrants any further energy auditing work. Some of the tasks involved in this step are • Identify the customer's concerns and needs • Check the current operating and maintenance procedures • Determine the existing operating conditions of major energy use equipment (lighting,HVAC systems, motors, etc.) • Estimate the occupancy, equipment, and lighting (energy use density and hours of operation).

(3)Baseline for Building Energy Use: The main purpose of this step is to develop a base-case model that represents the existing energy use and operating conditions for the building. This model will be used as a reference to estimate the energy savings due to appropriately selected energy conservation measures.

Evaluation of Energy-Saving Measures: In this step, a list of cost-effective energy conservation measures is determined using both energy savings and economic analysis.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project under ability enhancement can be assigned to an individual student or to a group havingnot more than 4 students.

Assessment Details (both CIE and SEE)

CIE procedure for project ability enhancement course:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concernedDepartment and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project reportshall be the same for all the batch mates.

Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college.

The CIE marks awarded for the project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be thesame for all the batch mates.

SEE for project:

(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.

(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

The SEE marks awarded for the project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be thesame for all the batch mates.

Course outcomes (Course Skill Set):

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

- Analyze the data collected for energy audit of a building or industry or organization.
- Perform comparative analysis with and without energy audit.
- Analyze the energy saving measures to be considered with economy considerations.
- Analyse in a systematic way, think better, and perform better

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be

decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

-

Project on Renewable Energy Sources		Semester	VI
Course Code	BEEL657D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

- Along with prescribed hours of teaching –learning process, provide opportunity to perform the experiments/programmes at their own time, at their own pace, at any place as per their convenience and repeat any number of times to understand the concept.
- Provide unhindered access to perform whenever the students wish.
- Vary different parameters to study the behavior of the circuit without the risk of damaging equipment/ deviceor injuring themselves.

Students can select appropriate projects with the approval of the guide. The projects be applicationoriented and can be considering any of the following or any other.

Automatic solar tracking system.
Solar based small traffic control system.
Solar mobile charger.
Vertical axis wind turbine system.
Solar powered Smart irrigation system.
Renewable energy based home automation system.
Domestic illumination using solar.
Solar grass cutter.
Solar UPS.

Course outcomes (Course Skill Set):

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

(1) Analyse in a systematic way, think better, and perform better.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project under ability enhancement can be assigned to an individual student or to a group having not more than 4 students.

Assessment Details (both CIE and SEE)

CIE procedure for project ability enhancement course:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college.

The CIE marks awarded for the project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for project:

(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.

(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

The SEE marks awarded for the project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

-