Programme: B.E. Electrical and Electronics Engineering			
Complex Analysis, Transform Techniques and Optimization			
Course Code	**1BMATEE301**	Scheme	2025
Type of Course	Applied Science Course (ASC)	Semester	III
Teaching Hours/Week (L:T:P)	42:28:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/(SL&TW):	42:28:0:50	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcomes

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

CO1: Apply the concepts of analytic functions, Cauchy-Riemann equations, complex integration, Cauchy's theorem, and Cauchy's integral formula to solve engineering and mathematical problems involving complex variables.

CO2: Develop Fourier series representations of periodic functions and perform harmonic analysis for functions with different periodicities, discontinuities, and symmetry properties.

CO3: Utilize Fourier transforms and Z-transforms, including their inverse transforms and properties, to analyse signals and solve difference equations arising in engineering applications.

CO4: Apply probability distributions, sampling theory, and statistical hypothesis testing techniques for analysing uncertainty and making data-driven decisions.

CO5: Formulate and solve linear programming problems using graphical, simplex, and Big-M methods to obtain optimal solutions in engineering and management applications.

Module-1

Complex Analysis: Review of a function of a complex variable, limits, continuity and differentiability. Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms and consequences. Construction of analytic functions by Milne-Thomson method, Problems on electric flux.

Complex integration: Line integral of a complex function, Cauchy's theorem and Cauchy's integral formula and problems.

Number of Hours: 08+05

Module-2

Fourier Series: Periodic functions, Euler's Formula, Conditions for Fourier expansion (Dirichlet's condition), Fourier series of functions i) having points of discontinuity, ii) with period 2π, iii) with change of interval (arbitrary period) and iv) Even and odd functions. Half rang Fourier series. Practical harmonic analysis.

Number of Hours:08+05

Module-3

Infinite Fourier transforms: Definition, Fourier transforms, Fourier sine, and cosine transforms. Inverse Fourier Transforms, inverse Fourier sine and cosine transforms. Problems.

Z-transforms: Definition, Standard Z-transforms, Damping, and shifting rules, Statements of initial value theorem and Final Value Theorem. Inverse Z-transform and applications to solve difference equations.

Number of Hours:09+06

Module-4

Probability Distributions: Review of basic probability theory, Random variables-discrete and continuous. Probability distribution function, cumulative distribution function, Mathematical Expectation-mean and variance. Repeated Trials- Binomial, Poisson, Normal and Exponential distribution (without proofs for mean and SD).

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test

of hypothesis for means, single proportions only. Student's t-distribution, Chi-square distribution as a test of goodness of fit.

Number of Hours: 09+06

Module-5

Linear Programming Problems: Introduction to optimization techniques, formulation of the problems. Introduction to Linear programming, graphical solution, solution by simplex and Big M method.

Number of Hours:08+06

Textbooks

(i)Higher Engineering Mathematics, B.S. Grewal, 45th Edition, Khanna Publishers.
(ii)Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India.
(iii)Higher Engineering Mathematics, H.K. Dass and Er. Rajnish Verma, S. Chand Publications.

Reference books

(i)Complex Variables and Applications by James Ward Brown and Ruel V. Churchill, McGraw-Hill Education.
(ii) Fourier Series and Boundary Value Problems by Ruel V. Churchill and James Ward Brown.
(iii)Probability and Statistics for Engineers and Scientists by Ronald E. Walpole et al., Pearson Education.
(iv)Operations Research by Hamdy A. Taha, Pearson Education.
(v) Schaum's Outline of Complex Variables, McGraw-Hill.

Web links and Video Lectures (e-Resources):

(i)NPTEL Courses on Engineering Mathematics
(ii)MIT Open Course Ware Mathematics
(iii)SWAYAM Online Courses.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(a)Flipped Classroom Approach

(i)Students review video lectures and reading materials before class.
(ii)Classroom sessions focus on problem-solving, discussions, and applications of transform techniques and optimization models.

(b)Problem-Based Learning (PBL)

Real-world engineering problems involving Fourier Transforms, Z-Transforms, and Linear Programming are assigned for collaborative solution development.

(c)ICT-Enabled Teaching (may be conducted in Tutorial hours)

Use of MATLAB, Python, and online simulation tools to visualize transforms, optimization problems, and signal-processing applications.

(d)Collaborative Learning (may be conducted in Tutorial hours)

Group assignments and mini-projects on optimization models and transform applications.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment (at RBL3 levels)	10
2.	GATE-based Aptitude Test	15

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Understanding of Concepts	Demonstrates excellent conceptual clarity and application	Good understanding with minor errors	Basic understanding	Poor understanding	Understanding of Concepts
Problem Solving Ability	Solves all problems correctly with proper methodology	Solves most problems correctly	Partial solutions with errors	Unable to solve problems effectively	Problem Solving Ability
Mathematical Accuracy	Calculations and derivations are error-free	Minor computational errors	Several errors	Significant errors	Mathematical Accuracy
Presentation & Organization	Well-structured, neat, and professionally presented	Organized with minor deficiencies	Average presentation	Poor presentation	Presentation & Organization

Suggested Learning Activities may include (but are not limited to):

Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels),GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):

Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits,ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours per Semester**
1.	Group Assignment on Applications of Complex Variables in Electrical Engineering (AC circuits, electric flux, potential theory)	20
2.	MATLAB/Python Exploration of Fourier and Z-Transforms	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours/ Semester**
1.	Conformal transformations: Discussion of transformations: $w = z^2, w = e^z, w = z + \frac{1}{z}, z \neq 0$, Bilinear transformation	30
2.	Complex form of Fourier series	
3.	Convolution theorem for Fourier transforms and Z transforms. Applications of transforms to boundary value problems	
4.	Joint probability distributions.	
5.	Dual simplex method.	

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Analog Electronics Circuits			
Course Code	**1BEE302**	Scheme	2025
Type of course	**Integrated Professional core**	Semester	III
Teaching Hours/Week (L:T:P)	3:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P: (SL:TW)	42: 0: 28:50	SEE Marks	50
Credits	**4**	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	3

Course outcome

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

CO1: Explain the operating principles, characteristics and applications of semiconductor diodes, rectifiers, Bipolar Junction Transistors (BJTs) and FETs in different configurations.

CO2: Apply the principles of BJT and FET biasing techniques, small-signal models, and AC/DC analysis to determine the operating point and performance of electronic circuits.

CO3: Analyse the frequency response, multistage amplifiers, feedback amplifiers, oscillators, and power amplifier circuits to evaluate their performance under different operating conditions.

CO4: Design electronic circuits using BJTs and FETs, including biasing networks, amplifiers, oscillators, feedback circuits, and power amplifiers to meet specified performance requirements.

CO5: Apply modern engineering tools and professional practices to design, analyse, and implement engineering solutions while demonstrating ethical responsibility, effective communication, teamwork, and project management skills.

Module-1

Semiconductor Diode: Introduction, semiconductor materials, working principle and forward and reverse bias conditions, resistance levels, diode equivalent circuit, transition and diffusion capacitance, reverse recovery time. Half-wave and full-wave rectifiers, necessity of clippers and clampers, different types of clippers and clampers. Zenor diode, power Supply and series and parallel Voltage Regulators. Light emitting diodes (LEDs)

Bipolar Junction Transistors: Introduction, NPN and PNP transistors, construction, operation. Characteristics of common base (CB), common emitter (CE) and common collector configuration, cutoff region, active region, and saturation region. Relation between collector current, base current and emitter current. Number of Hours: 09

Module-2

BJT Biasing: Introduction to biasing, operating point, bias configurations; fixed-bias, emitter bias, voltage-divider bias, DC bias with voltage feedback, design of bias circuits, effect of temperature on bias; thermal runaway, bias stabilization, stability, stability factors of bias circuits.

BJT AC Analysis: Amplification in AC domain, Transistor modelling for small signal analysis; resistance (r_e) model of CB, CE, and CC configurations, hybrid equivalent model CB, CE, and CC configurations, hybrid π model. Low frequency analysis, high frequency analysis. Number of Hours:09

Module-3

BJT AC Analysis: Determination voltage and current gains, effect of R_L and R_S. General frequency considerations, low frequency response, miller's capacitance, high frequency response. Amplifier operation, common emitter amplifier - DC and AC analysis (base and voltage divider bias only), multistage amplifier, Cascade and cascode connections, amplifier frequency response: decibel scale, Darlington circuits, analysis and design. Number of Hours: 08

Module-4

Feedback Amplifiers: Feedback concept, different types, practical feedback circuits, analysis and design of feedback circuits. Feedback amplifier; phase and frequency considerations, oscillators operation, phase-shift, Wien-bridge, tuned and crystal oscillators.

Power Amplifiers: Classification, analysis and design of Class A – Directly Coupled and Transformer Coupled, Class B- Complementary Symmetry and Push Pull, Class C and Class AB. Number of Hours: 08

Module-5

Field Effect Transistors: Introduction to FET, Construction, difference between FET, JFET and metal oxide Semiconductor Field Effect Transistor (MOSFET), N-Channel and P-Channel MOSFET in the Enhancement Mode and Depletion Mode, Characteristics, Transfer Characteristics, Fixed Bias, Self Bias and Voltage Divider Bias, DC and AC Analysis. Number of Hours:08

Laboratory component (experiments) of the IPCC Analog Electronic Circuits

(1) Design and verify a full wave bridge rectifier with and without a capacitor filter for given output voltage obtainable from 230 V supply. Determine the performance parameters.
(2) Experiments on clippers and clampers.
(3) Static Transistor characteristics for CE, CB and CC modes and determination of h parameters.
(4) Single stage BJT RC coupled CE amplifier and determination of voltage gain, current gain, input and output impedances. Determine the bandwidth from the frequency response curve.
(5) Single stage FET RC coupled CE amplifier and determination of voltage gain, current gain, input and output impedances.
(6) Determination of gain, input and output impedance of BJT Darlington emitter follower with and without bootstrapping and determine gain and bandwidth from its frequency response curve.
(7) Conduct an experiment on BJT cascode configuration and determine the dynamic resistance, gain of each transistor and the overall no load gain.
(8) Conduct an experiment on a class B push-pull emitter-follower power amplifier to determine rms output power, DC supply power supplied to the amplifier and amplifier percent efficiency
(9) Design a BJT - Crystal Oscillator for a given frequency.
(10) Design a FET Hartly oscillator for a given frequency.

Textbooks:

(i) Electronic Devices and Circuit Theory, Robert L. Boylestad, Pearson Education, 12th edition.
(ii)Electronic Devices (Conventional Current Version), Thomas L. Floyd, Pearson Education, 10th edition (Global edition), 2018.
(iii)Electronic Devices and Circuits, David A Bell, Oxford University Press,5th Edition, 2008.

Reference books:

(i) Electronic principles, Albert Malvino and David Bates, McGraw-Hill publication, 8th edition, 2016.
(ii) A Textbook of Electrical Technology, Electronic Devices and Circuits, B.L. Theraja, A.K. Theraja, S. Chand Reprint, 2013.

Web links and Video Lectures (e-Resources)

1. **https://falstad.com/circuit/?utm_source**
2. **https://www.analog.com/ltspice?utm_source**
3. **https://vlab.co.in/?utm_source**
4. **https://www.nptel.ac.in/courses/117101106?utm_source**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Interactive lectures using ICT tools and multimedia content.
(ii) Flipped classroom and blended learning approaches.
(iii)Problem-based and project-based learning.
(iv)Simulation-based learning using Multisim/PSpice/LTspice/MATLAB, wherever possible.
(v)Laboratory experiments and hands-on activities, wherever possible.
(vi) Collaborative learning, peer learning, and group discussions.
(vii)Case studies and design-oriented assignments.
(viii) Self-learning through NPTEL, SWAYAM, and other MOOCs.

Assessment Structure:
The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

The CIE Theory component consists of IA tests for 25 marks. The CIE Practical component for continuous assessments will be for 15 marks through rubrics and for lab tests will be for 10 marks.

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE Practical component:
The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The summation of all the experiments marks to be scaled down to 15 marks.
The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 10 marks. For laboratory test, the student is required to conduct one experiment.

Suggested Learning Activities may include (but are not limited to:

- Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels),GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels),Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits,ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1	Faculty handling the subject can decide	10 Hrs
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self Learning**	**Number of Hours / Semester**
1.	Faculty handling the subject can decide	10 Hrs

Continuous Internal Evaluation (CIE)

(i)Theory component

The CIE marks of 25 shall be earmarked for two tests.
The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.
Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

(ii) Laboratory component

Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed in the course syllabus.

The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined for regular class work and practical test as indicated in the Table – ICs/IPCCs 1.

(i) To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Table – ICs/IPCCs 1 Distribution of marks		
Component	**Description**	**Marks**
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
	Subtotal	**15**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
	Subtotal	**10**
	Total	**25**

PI	**5 – Excellent**	**4 – Very Good**	**3 – Good**	**2 – Fair**	**1 – Poor**
Ability in Conducting Experiments (5M)	Independently sets up the experiment, follows all safety practices, demonstrates excellent skill in handling equipment, works effectively in a team, and completes the experiment accurately without assistance.	Performs the experiment with minimal guidance, follows safety rules, handles equipment correctly, and completes the task with minor errors.	Performs the experiment with occasional guidance, follows most safety practices, and completes the experiment with acceptable accuracy.	Requires frequent assistance in setup and execution, follows safety practices inconsistently, and produces partially correct results.	Unable to perform the experiment independently, ignores safety practices, mishandles equipment, and fails to obtain meaningful results.
Laboratory Record (10M)	Record is complete, neat, well-organized, accurate, includes correct observations/results, and is submitted on time.	Record is complete with minor errors, neatly maintained, accurate, and submitted on time.	Record is reasonably complete with some inaccuracies, acceptable presentation, and submitted with slight delay.	Record is incomplete, poorly organized, contains several errors, and submitted late.	Record is missing, highly incomplete, inaccurate, or not submitted.

Laboratory Test / Experiment Performance(5M)	Independently sets up the apparatus, follows the correct procedure, records accurate observations, analyzes results correctly, and completes the experiment successfully.	Performs the experiment with minor procedural errors and obtains reasonably accurate results.	Performs the experiment with guidance, records acceptable observations, and obtains partially correct results.	Requires continuous assistance, follows procedure incorrectly, and produces unreliable results.	Unable to perform the experiment or obtain valid observations/results.
Viva-Voce(5M)	Demonstrates excellent understanding of theory, experimental procedure, calculations, observations, and confidently answers all questions with proper reasoning.	Demonstrates good conceptual understanding and answers most questions correctly with minor errors.	Shows satisfactory understanding and answers basic questions correctly but lacks depth.	Demonstrates limited understanding and answers only a few questions correctly with significant prompting.	Demonstrates poor understanding of concepts and is unable to answer basic questions.

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Electric Circuit Analysis			
Course Code	**1BEE303**	Scheme	2025
Type of Course	Professional Core Course	Semester	III
Teaching Hours/Week (L:T:P)	3:1:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:28:0:50	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome

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

CO1: Explain the concept of basic methods, theorems and Laplace Transformation.

CO2: Explain the electric resonance, Trainset analysis, unbalanced circuits, Two-port Networks.

CO3: Apply the various methods, Theorems & Two-port Networks to solve electric circuits.

CO4: Analyse electrical systems using concept of Resonance, Transient & Laplace Transformation.

CO5: Prepare a report on Simulation of Electric Circuits using AI techniques.

Module-1

Electric Circuits: Introduction to electric circuit, Classification of circuits, Concept of ideal and practical sources. Independent and dependent current and voltage sources, Source transformation and Source shifting, Star- Delta transformation. Analysis of networks by Mesh Current and Node voltage methods for DC and AC circuits with independent and dependent sources. Concept of Super-Mesh and Super-Node analysis. Duality.

Number of Hours:09

Module-2

Network Theorems: Superposition theorem, Reciprocity Theorem, Thevenin's theorem, Norton's theorem and Maximum power transfer theorem. DC and AC circuit analysis of networks with and without dependent sources.

Number of Hours:08

Module-3

Resonant Circuits: Analysis of simple series R-L-C and parallel R-L-C circuits under resonances. Derivation of Resonant frequency, cut-off frequency, bandwidth and quality factor at resonance. Examples on simple series R-L-C and parallel R-L-C circuits.

Initial and Final Conditions: Definition of initial and final condition, Virtues of initial conditions, Behaviour of circuit elements for initial and final condition, Evaluation of initial conditions for series and parallel circuits.

Transient Analysis: Transient analysis of R-L and R-C circuits under DC excitations, Examples on simple R-L and R-C Circuits.

Number of Hours:09

Module-4

Laplace Transformation (LT): Introduction to Laplace transformation, Solution of electrical circuits using LT, Transformed electrical circuit, Laplace transformation of standard signals: Impulse, Step, Ramp, Sinusoidal signals and shifted functions. shifting theorem, Initial and Final value theorems, Waveform Synthesis, Laplace transformation of periodic waveform.

Number of Hours:08

Module-5

Unbalanced Three Phase Systems: Analysis of three phase unbalanced systems, Neutral shifting method, Calculation of real and reactive Powers.

Two Port networks: Definition, necessity of two port networks, Open circuit impedance, short circuit admittance and Transmission parameters, Relation among all the three parameters, Evaluation of two port networks for simple circuits.

Number of Hours:08

Textbooks

(i)Electric Circuits, Joseph, A Edminister, Schaum's Series, Mc Graw Hill.

(ii)Engineering Circuit Analysis, William H Hayt et al, Mc Graw Hill,8th Edition,2014.

(iii)Network Analysis M.E. Van Valkenburg, Pearson, 3rd Edition,2014.

(iv)Fundamentals of Electric Circuits Charles K Alexander Matthew N O Sadiku, McGraw Hill, 5th Edition, 2013.

Reference Books

(i)Networks and Systems D. Roy Choudhury, New Age International Publishers, 2nd edition.

(ii)Circuits by A Bruce Carlson, Cengage Learning Indian Pvt. Ltd,1st Reprint, 2008.

(iii)Circuits and Networks-Analysis and Synthesis Sudhakar. A and Shyammohan S P, Tata McGraw Hill,1995.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/108105159?utm_source=chatgpt.com
https://www.nptel.ac.in/courses/108104139?utm_source=chatgpt.com
https://nptel.ac.in/courses/108102097?utm_source=chatgpt.com

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Problem-based learning through circuit analysis and design exercises.
(ii)Interactive lectures using ICT tools and visualisation techniques.
(iii)Simulation-assisted learning using industry-standard software tools.
(iv)Tutorial sessions for numerical problem-solving and analytical skills.
(v)Collaborative learning through group discussions and case studies.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
PI-1: CO1 Apply circuit laws & source models	Correctly classifies circuits & draws ideal/practical sources with explanation	Classifies circuits with minor errors in source models	Basic classification, confuses ideal vs practical	Major errors in classification	No attempt
PI-2: CO2 Perform Source transformation & Star-Delta	Performs source shifting & Star-Delta without errors, verifies equivalence	1 error in transformation but correct logic	Multiple errors, partial equivalence	Cannot perform transformation	No attempt
PI-3: CO3 - Analyze by Mesh & Node with dependent	Correct KVL/KCL, handles dependent sources, identifies Super-Mesh/Node	Correct method, 1-2 calculation errors	Method correct but dependent source mishandled	Wrong method applied	No solution
PI-4: PO2 - Problem Analysis & PO3 - Design	Explains Duality with example & validates result by 2 methods	Explains Duality, validates by 1 method	Mentions Duality without example	No explanation of Duality	No participation
PI-1: CO2 - Apply Superposition & Reciprocity	Correctly applies both theorems, explains when each is valid	Applies with minor error, basic explanation	Applies 1 theorem correctly	Confuses theorem conditions	No application
PI-2: CO3 - Use Thevenin & Norton with dependent sources	Finds Vth,Rth,IN correctly including dependent source deactivation rules	Minor error in Rth with dependent source	Finds Vth only, ignores dependent source rule	Incorrect equivalent circuit	No attempt
PI-3: CO4 - Maximum Power Transfer	Proves RL=Rth condition & calculates Pmax for AC/DC	Calculates Pmax with minor error	States condition but wrong calculation	No relation to Rth	No attempt
PI-4: PO5 - Tool Usage & PO4 – Analysis	Verifies theorem results using software & interprets difference	Verifies 1 theorem using tool	Mentions tool but no verification	No tool usage	No participation

PI-1: CO1 - Derive Resonance	Derives fr,f1,f2 ,BW,Q for series & parallel with graphs	Derives with minor error, 1 circuit type	Formula correct, no derivation	Only formulas, no derivation	No derivation
PI-2: CO2 - Initial & Final Condition Analysis	Correctly applies iL(0+),vC(0+) rules & explains "virtues"	Correct values, weak explanation	1 mistake in initial condition	Confuses L and C behavior	No analysis
PI-3: CO3 - Transient Analysis of RL/RC	Solves complete response: Natural + Forced, plots waveform	Correct equation, minor error in constants	Only steady state or transient part	Wrong differential equation	No solution
PI-4: PO1 - Engineering Knowledge	Relates resonance & transient to real applications like filters, relays	Gives 1 application	Mentions application without detail	No application	No participation
PI-1: CO2 - LT of standard signals	Correct LT of Impulse, Step, Ramp, Sin & shifted functions	1 error in standard LT	2-3 errors in LT table	Confuses time & s-domain	No LT done
PI-2: CO3 - Circuit solution using LT	Draws s-domain circuit, solves & takes inverse LT correctly	Correct method, inverse LT error	s-domain correct, cannot invert	Wrong s-domain model	No solution
PI-3: CO4 - Apply IVT, FVT & Shifting theorem	Applies both theorems to verify solution & uses shifting correctly	Applies 1 theorem correctly	Mentions theorem without use	Incorrect theorem use	No attempt
PI-4: PO2 - Complex Problem Solving	Solves periodic waveform using LT & interprets result	Solves with minor error	Attempts periodic but incomplete	Cannot handle periodic	No attempt
PI-1: CO2 - Unbalanced 3-Phase Analysis	Uses Neutral Shift method correctly, calculates P, Q with phasor diagram	Correct method, minor error in P/Q	Method partial, no phasor	Wrong method	No analysis

PI-2: CO3 - Two Port Parameter evaluation	Finds Z, Y, ABCD for given circuit & proves inter-relations	Finds 2 parameters correctly	Finds 1 parameter correctly	Wrong parameter definitions	No attempt
PI-3: CO4 - Necessity & Application	Explains need of 2-port in cascaded systems with example	Explains necessity with basic example	States necessity only	No explanation	No participation
PI-4: PO3 - Design & PO5 - Modern Tools	Models 2-port in software & validates parameter conversion	Models 1 parameter set	Mentions software	No tool use	No participation

Suggested Learning Activities may include (but are not limited to):

- Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels),GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):

Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1	Analyze a given DC/AC circuit with dependent source using Mesh, Node	06
2	Source Transformation & Star-Delta	04
3	Verify results and explain Duality	02
4	For a given network with/without dependent source, find load voltage/current & Pmax using Thevenin, Norton, Superposition, Reciprocity.	08
5	Verify by simulation.	04
6	Analyze series & parallel RLC for resonance	04
7	Derive fr, BW, Q	04
8	Find initial/final conditions and transient response of RL/RC to DC.	04

9	Solve RL/RC circuit for step input using LT	04
10	Apply shifting theorem, IVT, FVT	04
11	Find response for periodic waveform.	04
12	Analyze unbalanced 3-phase load by Neutral Shift method.	04
13	Find Z, Y, ABCD parameters of given 2-port & interconvert them.	04
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Digital Electronic Circuits			
Course Code	**1BEE304**	Scheme	2025
Type of Course	**Professional Core Course**	Semester	III
Teaching Hours/Week (L:T:P)	3:0: 0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome

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

CO1: Apply Boolean algebra and Karnaugh Maps (K-Maps) to simplify logic expressions and realise digital logic functions.

CO2: Design and analyse combinational logic circuits including decoders, encoders, multiplexers, adders, subtractors, and binary comparators.

CO3: Analyse and design sequential logic circuits using latches, flip-flops, registers, and counters.

CO4: Develop state diagrams and design synchronous sequential circuits using Mealy and Moore models.

CO5: Evaluate the characteristics and applications of digital integrated circuits, memory devices, and logic families such as TTL and CMOS.

Module-1

Principles of Combinational Logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables, incompletely specified functions (Don't care terms) Simplifying Max term equations, Quine-McCluskey minimization technique, Quine-McCluskey using don't care terms, Reduced prime implicants Tables. Design with Basic gates, NAND gates and NOR gates.

Number of Hours: 08

Module-2

Analysis and Design of Combinational logic: General approach to combinational logic design, Decoders, BCD decoders, Encoders, digital multiplexers, using multiplexers as Boolean function generators, Adders and subtractors, Cascading full adders, Look ahead carry, Binary comparators.

Number of Hours: 08

Module-3

Flip-Flops: Basic Bistable elements, Latches, Timing considerations, The master-slave flip-flops (pulse triggered flip-flops): SR flip-flops, JK flip-flops, Edge triggered flip- flops, Characteristic equations.

Flip-Flops Applications: Registers, binary ripple counters, synchronous binary counters, Counters based on shift registers, Design of a synchronous counter, Design of a synchronous mod-n counter using clocked T, JK, D and SR flip-flops.

Number of Hours: 09

Module-4

Sequential systems: Analysis of Clocked Sequential circuits, State Reduction and Assignment, Design Procedure, Design with State Equations, Sequence detector.

Sequential Circuit Design: Mealy and Moore models, State machine notation, Synchronous Sequential circuit analysis. Construction of state diagrams, counter design.

Number of Hours: 09

Module-5

Memories: Read only and Read/Write Memories, Programmable ROM, EPROM, Flash memory.

Logic Families: Characteristic of Digital ICs, Transistor – Transistor Logic (NOT, NAND, NOR), Complementary MOS Logic (NOT, NAND, NOR), Comparison of TTL and CMOS families.

Number of Hours: 08

Textbooks

(i) Digital Principles and Design, Donald D. Givone, McGraw Hill,2002.
(ii) Digital Design, Morris Mano, Prentice Hall of India, Third Edition.

Reference Books

(i) Digital Logic Applications and Design, John M Yarbrough, Thomson Learning, 2001.
(ii) Fundamentals of logic design, Charles H Roth,Jr, Cengage Learning. Fifth Edition.
(iii) Digital Systems Design, A Nagoor Kani, CBS Publishers and Distributors, 2026.

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee177
2. https://nptel.ac.in/courses/106105185/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Interactive lectures using ICT tools and multimedia content.
(ii) Flipped classroom and blended learning approaches.
(iii)Problem-based, project-based learning, Collaborative learning, peer learning, and group discussions learning.
(iv) Simulation-based learning using digital design software tools for combinational and sequential circuits.
(v) Self-learning through NPTEL, SWAYAM, and other MOOCs.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	To develop mini projects using digital electronics concepts	15
2.	To simulate the digital electronics circuits using any open source software	10

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Learning Activity 1 (To develop mini projects using digital electronics concepts)

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 Type and quality of project and implementation (10) (CO2- PO1; CO3- PO3)	Project selected is standard and contributes to societal needs (10)	Project selected is good but not relevant to societal needs (8)	Project selected is very simple and does not contribute to societal needs (6)	Project selected is not relevant to topics in the course and does not contribute to societal needs (4)	The project chosen is similar to the lab experiment (2)
Performance Indicator-2 Able to present and develop technical report for the mini project activity (5) (CO5 – PO9)	Able to excellently comprehend the objectives, methodology and results of mini project in technical report and communicate the same (5)	Able to excellently comprehend the objectives, methodology and results in technical report and not able to communicate the same (4)	Objectives and methodology are not clearly specified and report writing as well as communication needs improvement (3)	Requires improvement in report writing and presentation skills (2)	Fails to comprehend the project details and present the same (1)

Learning Activity 2 (To simulate the digital electronics circuits using any open source software)

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator Able to simulate the digital electronics circuits (10) (CO2/PO5 Mapping)	Able to simulate complex digital circuits and analyse the results obtained (10)	Able to simulate simple digital circuits and analyse the results obtained (8)	Able to simulate simple digital circuits but fairly able to analyse the results obtained (6)	Able to simulate simple digital circuits but not able to analyse the results obtained (4)	Not able to simulate and analyse even simple circuits (2)

Suggested Learning Activities may include (but are not limited to):

-Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):		
-Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.		
Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Assignments	24
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Online educational resource (8 week NPTEL course) / video lectures	24

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Transformers and Generators			
Course Code	**1BEE305**	Scheme	2025
Type of Course	Professional Core course	Semester	III
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/(SL&TW):	42: 0: 0 :48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome

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

CO1: Explain the construction, operation and performance of single-phase transformers.

CO2: Analyse the operation, and performance of parallel operation of three-phase transformers.

CO3: Evaluate the construction, operation and performance and applications of special transformers.

CO4: Analyse the construction, operation and performance of synchronous generators.

CO5: Evaluate the steady-state performance of salient-pole and cylindrical-rotor synchronous generators.

Module-1

Single phase Transformers: Necessity of transformers, principle of operation, Constructional details of core and windings, EMF equation, equivalent circuit, Operation of practical transformer under no-load and on load with phasor diagrams. Losses, Variation of losses with load, methods of reducing losses. Efficiency and condition for maximum efficiency. Reasons for rating of transformers in kVA. Open circuit and short circuit tests, calculation of equivalent circuit parameters. Polarity test, Sumpner's test. Predetermination of efficiency, voltage regulation and its significance. parallel operation of single-phase transformers. Numerical Problems.

Number of Hours:08

Module-2

Three-phase Transformers: Introduction, Three phase transformers in single units or in banks of three, Transformer connection for three phase operation– star/star, delta/delta, star/delta, and delta/open delta, comparative features with reference to vector group, Labelling of three-phase transformer terminals, Parallel Operation of Transformers: Necessity of Parallel operation, conditions for parallel operation of three phase transformers including vector group conditions, Load sharing in case of similar and dissimilar transformers., Numerical Problems.

Number of Hours:09

Module-3

Three-Phase Transformers(continued): Voltage regulation by Tap changing on load and on no-load. Scott connected transformer, Necessity of transformers with tertiary windings. transformer Noise.

Autotransformers: Introduction, copper economy, equivalent circuits, numerical problems.

Instrument transformers- Current Transformers (CT) and Potential Transformers (PT): Construction, Operation, and Applications.

Welding transformers: construction and operation. Introduction to pulse transformer.

Number of Hours:08

Module-4

Synchronous Generators: Constructional features of salient and cylindrical types, excitation systems – static and brushless, working, Armature windings, winding factors, EMF equation; Harmonics–causes, reduction and elimination; Armature reaction, Synchronous reactance, Equivalent circuit; Synchronous Generators Analysis: Open circuit and short circuit characteristics, short circuit ratio, Alternator on load; Voltage regulation, Voltage regulation by EMF, MMF, and ZPF methods; Excitation control for constant terminal voltage when operating on its own load and on infinite bus. Numerical Problems.

Number of Hours: 09

Module-5

Synchronous Generators (Salient Pole): Effects of saliency, two-reaction theory, Direct and quadrature axis reactances, slip test, electromagnetic power developed in the salient generators. Power angle characteristic (salient and non-salient pole), power angle diagram, reluctance power, capability curve for large turbo generators. Parallel operation of generators and load sharing; Methods of synchronization, Synchronizing power, Hunting and damper windings. Numerical Problems.

Number of Hours: 08

Textbooks:

(i)Electric Machines, D. P. Kothari, et al, 4th Edition, 2011.
(ii)Electric Machines, Ashfaq Hussain, Dhanpat Rai & Co, 2nd Edition, 2013.
(iii)Electric Machinery, P.S. Bimbhra, Khanna Publishers.
(iv) Theory & Performance of Electrical Machine, J.B. Gupta, S.K. Kataria & Sons.

Reference books:

(i)Electric Machinery, A E Fitzgerald, Charles Kingsley, Stephan Umans, McGraw-Hill.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Interactive lectures using ICT tools and multimedia content.
(ii) Flipped classroom and blended learning approaches.
(iii)Problem-based and project-based learning.
(iv)Simulation-based learning using Multisim/PSpice/LTspice/MATLAB, wherever possible.
(v)Laboratory experiments and hands-on activities, wherever possible.
(vi) Collaborative learning, peer learning, and group discussions.
(vii)Case studies and design-oriented assignments.
(viii) Self-learning through NPTEL, SWAYAM, and other MOOCs.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Self-Learning- (Open Book test/Assignments /Video Based Learning/Virtual Lab.etc)	15
2.	Group Activity: Industrial Visit and Technical Report	10

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for

Activity	Performance Indicator	Excellent	Very Good	Good	Fair	Needs Improvement
Self-Learning (15 Marks)	Technical Understanding, Self-Learning (CO1–CO5 → PO1, PO2, PO10, PO12)	Completes the assignment/ open book test accurately neatly presented, and submitted/written on time. (15-14)	Completes the assignment neatly presented, with only minor errors or omissions. Submitted on time. (13-11)	Applies concepts to a few problems using an acceptable approach. (10-7)	Completes only part of the assignment with limited understanding of the concepts. (6-4)	Assignment is incomplete, inaccurate, or not submitted on time. (3-1)
Group Activity: Industrial Visit and Technical Report (10 Marks)	Technical Observation, Understanding & Report Quality (CO2–CO5 → PO1, PO2, PO10, PO12)	Demonstrates excellent understanding of industrial processes and submits a well-structured report (10-9)	Demonstrates good understanding with relevant observations and a well-organized report with minor deficiencies. (8-7)	Demonstrates satisfactory understanding with basic observations and an acceptable report. (6-5)	Demonstrates limited understanding with weak observations and poor documentation. (4-3)	Demonstrates inadequate understanding and submits an incomplete or unacceptable report. (2-1)

Suggested Learning Activities may include (but are not limited to):
-Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.
Suggested Innovative Delivery Methods may include (but are not limited to):
-Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Industrial Visit to a Transformer Manufacturing Industry / Power Station / Electrical Substation	8
2.	Preparation and Submission of Industrial Visit Technical Report	8
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Open Book Learning Activity / Concept-Based Problem Solving / Assignment	16
2.	Virtual Lab / Simulation-Based Learning	8
3.	Technical Video Learning	8

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Transformers and Generators Lab			
Course Code	**1BEEL306**	Scheme	2025
Type of Course	Professional Core Course Lab	Semester	III
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P: (SL&TW)	0:0:28:2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**Practical**	Exam Hours	3

Course objectives:

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

CO1: Conduct standard tests on single-phase and three-phase transformers and determine equivalent circuit parameters and performance.

CO2: Analyse the performance of transformers under different operating conditions.

CO3: Perform experimental investigations on synchronous generators and to determine their performance.

CO4: Evaluate the voltage regulation of synchronous generators using different standard methods, to compare the results obtained.

CO5: Determine the steady-state operating characteristics of synchronous generators.

List of experiments

(1)Open-circuit and short-circuit tests on a single-phase step-up/step-down transformer and pre-determination of: (i) Efficiency and regulation, and (ii) Parameters of the equivalent circuit.

(2)Polarity Test and Star–Delta Connection of Three Single-Phase Transformers with Efficiency and Regulation under Balanced Load.

(3)Determination of Combined and Individual Transformer Efficiencies using Sumpner's Test.

(4)Parallel operation of two dissimilar single-phase transformers of different kVA ratings and determination of load sharing.

(5)Separation of hysteresis and eddy current losses in a single-phase transformer.

(6)Comparison of performance of three single-phase transformers in delta–delta and V–V (open-delta) connections under load.

(7) Scott connection for conversion of 3 phase supply to 2 phase supply and plot of secondary side voltages with respect to load variation.

(8)Direct load test on a three-phase synchronous generator to determine efficiency and regulation.

(9) Determination of voltage regulation of an alternator by the EMF and MMF method.

(10) Determination of power-angle characteristics of a synchronous generator and determination of maximum power developed.

(11) Performance of a synchronous generator connected to an infinite bus under constant load and variable excitation.

(12)Slip test and determination of X_d and X_q.

Textbooks:

(i)Electric Machines, D. P. Kothari, et al, 4th Edition, 2011.

(ii)Electric Machines, Ashfaq Hussain, Dhanpat Rai & Co, 2nd Edition, 2013.

(iii)Electric Machinery, P.S. Bimbhra, Khanna Publishers.

(iv) Theory & Performance of Electrical Machine, J.B. Gupta, S.K. Kataria & Sons.

Teaching-Learning Process (Innovative Delivery Methods):
The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Interactive lectures using ICT tools and multimedia content.
(ii) Flipped classroom and blended learning approaches.
(iii)Simulation-based learning using Multisim/PSpice/LTspice/MATLAB, wherever possible.
(iv)Laboratory experiments and hands-on activities, wherever possible with collaborative learning, peer learning, and group discussions.
(v) Self-learning through NPTEL, SWAYAM, and other MOOCs.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (5 Marks) (PO1)	The student has well depth knowledge of the topics related to the course (5)	Student has good knowledge of some of the topics related to course (4)	Student is capable of narrating the answer but not capable to show in depth knowledge (3)	Student has not understood the concepts clearly (2-1)
Experimental Setup and Performance of Experiment (10 Marks) (PO2 & PO3)	Independently identifies the apparatus, makes correct connections, follows safety precautions, performs the experiment systematically, and records accurate observations without assistance. (10–9)	Performs the experiment correctly with minor guidance or minor errors in setup or observations. (8–7)	Completes the experiment with guidance and records observations with a few errors. (6–4)	Requires significant assistance in connections, operation, or recording observations, and performs the experiment incompletely. (3–1)
Result & Analysis (5 Marks) (PO4)	Accurately analyses the experimental results, plots performance characteristics correctly, compares experimental and theoretical values, and provides valid conclusions. (5)	Correctly analyses the results with minor errors in calculations or interpretation. (4)	Performs basic calculations and analyses the results with limited interpretation. (3)	Performs incomplete calculations and is unable to interpret the results correctly. (2–1)
Laboratory Record and Documentation (5 Marks) (PO10)	Record is neat, complete, well-organized, and includes objectives, circuit diagrams, observations, calculations, graphs, and conclusions. (5)	Record is complete with minor omissions or formatting issues. (4)	Record contains essential details but lacks clarity or completeness.(3)	Record is incomplete, poorly organized, or missing key sections. (2-1)
Demonstration and Viva Voce (5 Marks) (PO9)	Explains simulation procedure, observations, and answers viva questions confidently and accurately. (5)	Explains procedure and answers most questions correctly. (4)	Explains basic concepts but requires prompting during viva. (3)	Unable to explain the experiment or answer viva questions satisfactorily (2-1)

Rubrics suggested for Laboratory Test				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Procedural Write-up (10 Marks) *(PO1)*	Writes the aim, circuit diagram, procedure, relevant equations, and expected outcome accurately and systematically. **(10-9)**	Writes the procedure with minor omissions or errors. **(8-7)**	Writes the basic procedure but misses important details. **(6-4)**	Incomplete or incorrect procedural write-up. **(3–1)**
Experimental Setup & Conduction (10 Marks) *(PO2, PO3)*	Correctly sets up the experiment, follows the procedure systematically, and performs the experiment independently. **(10–9)**	Completes the setup and experiment with minor errors or minimal guidance. **(8–7)**	Performs the experiment with guidance. **(6–4)**	Unable to perform the experiment without significant assistance. **(3–1)**
Observations, Calculations & Verification (10 Marks) ***(PO4)***	Records observations accurately, performs calculations correctly, verifies the results, and analyses the performance systematically. **(10–9)**	Performs calculations with minor errors and verifies the results satisfactorily. **(8–7)**	Performs basic calculations with partial verification. **(6–4)**	Unable to perform calculations or verify the results correctly. **(3–1)**
Results & Interpretation (10 Marks) *(PO4)*	Presents and interprets the results accurately, compares theoretical and simulated values, and draws appropriate conclusions. **(10–9)**	Presents results correctly with minor interpretation errors. **(8–7)**	Presents results with limited interpretation. **(6–4)**	Results are incomplete or incorrectly interpreted. **(3–1)**
Demonstration & Viva Voce (10 Marks) *(PO9)*	Demonstrates the experiment confidently and answers conceptual and application-based viva questions accurately. **(10–9)**	Demonstrates the experiment correctly and answers most questions satisfactorily. **(8–7)**	Demonstrates basic understanding and answers some questions with prompting. **(6–4)**	Unable to demonstrate the experiment or answer viva questions satisfactorily. **(3–1)**

Self-Learning (SL) and Term Work (TW) components in Number of Hours per semester (any one activity)

Sl. No.	Self-Learning & Term Work (TW) Activity	Number of Hours / Semester
1.	Review one IEEE paper, NPTEL lecture, or technical article related to transformers or synchronous generators and summarize the key learning outcomes.	2
2.	Explore simulation of transformer or synchronous generator characteristics using MATLAB/Simulink or any other simulation software.	2
3.	Develop a comparative chart showing transformer connections (Star–Star, Delta–Delta, Star–Delta, Delta–Star, Scott, and Open Delta) with applications.	2
4.	Prepare a maintenance checklist for transformers and synchronous generators based on industry practices.	2
5.	Analyse and present the industrial applications of different transformer connections with suitable illustrations	2

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Programme: B.E. Electrical and Electronics Engineering			
Multisim / PSpice Lab for Circuit Analysis			
Course Code	**1BEEL307A**	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL&TW	0:0:28:2	SEE Marks	50
Credits	**1**	Total Marks	100
Type of Examination	Practical	Exam Hours	2

Course outcome

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

CO1: Apply Kirchhoff's laws for analysis of circuit containing independent and dependent sources using Multisim/PSpice.

CO2: Simulate and verify fundamental network theorems, and interpret the simulation results.

CO3: Analyse AC circuits using simulation tools.

CO4: Determine the parameters and performance characteristics of two-port networks and evaluate circuit behaviour using Z-parameters and Y-parameters.

CO5: Perform transient analysis of RL and RC circuits using Multisim/PSpice and determine time constants, transient responses, and steady-state characteristics of electrical circuits.

List of EXPERIMENTS

Sl. No.	Experiments
1	Simulation and verification of Kirchhoff's Current Law & Kirchhoff's Voltage Law.
2	Simulation of Mesh Current analysis for a given circuit having an independent and dependent sources. Simulation to be effected separately for DC and AC excitations. Calculation of power for verification of conservation of power.
3	Simulation of Nodal Voltage analysis for a given circuit having an independent and dependent sources. Simulation to be affected separately for DC and AC excitations. Calculation of power for verification of conservation of power. Calculation of power for verification of conservation of power.
4	Simulate and verify Super Positions theorem.
5	Simulation and verification Reciprocity theorem.
6	Simulation and verification Thevenin's theorem.
7	Simulation and verification Norton's theorem.
8	Simulation and verification Maximum Power Transfer theorem. Simulation to be effected separately for DC and AC excitations. Determine the efficiency of the circuit when the power output is maximum.
9	Simulation of RL and RC circuit to measure voltage, current and phase difference between them. Calculate the impedance, impedance angle, and power consumed.
11	Determination of Z and Y parameters of a given two-port network.
12	Transient Analysis of the RC and RL Circuits. Determine the time-constants of the circuits.

Reference Books:

(i) Introduction to PSpice Using OrCAD for Circuits and Electronics, Muhammad H. Rashid, Pearson Education.
(ii) Engineering Circuit Analysis, William H. Hayt Jr. at el., McGraw-Hill Education.
(iii) Network Analysis, M. E. Van Valkenburg, Pearson Education India.
(iv) Circuit Systems with MATLAB and PSpice, Won Y. Yang and Seung C. Lee, John Wiley & Sons.

Web links and Video Lectures (e-Resources):

https://matlabacademy.mathworks.com/details/simulink-onramp/simulink
https://www.mathworks.com/help/physmod/sps/
https://www.mathworks.com/solutions/electrical-engineering.html
https://nptel.ac.in/courses/108105159

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Simulation-based learning using Multisim/PSpice for circuit analysis.
(ii)Virtual experimentation through DC and AC circuit simulations to analyse circuit behaviour.
(iii)Inquiry-based learning through comparative evaluation of theoretical calculations and simulation results.
(iv)Problem-solving learning using practical electrical circuits.
(v) Self-learning through NPTEL, SWAYAM, and other MOOCs.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE – Continuous assessment:

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
PI-1: CO1 - Circuit Construction PO1	Circuit built correctly with proper connections for both **KCL & KVL**	Minor connection error, corrected	Partial circuit, needs help	Incorrect circuit	No circuit
PI-1: CO2 - Mesh Equation Formulation PO2	Correctly forms **Mesh equations** with dependent source for DC & AC	1 error in dependent source term	Forms equations for only DC	Wrong equations	No equations
PI-1: CO2 - Nodal Equation Formulation PO2	Correct **Nodal equations** with super-node for dependent source DC & AC	Minor error in super-node	Equations for DC only	Incorrect equations	No equations
PI-1: CO3 - Circuit Setup PO3	Builds circuit, interchanges source & response points correctly	Minor error in interchange	Builds circuit only	Cannot interchange	No circuit
PI-1: CO3 - Circuit Setup PO3	Builds circuit, interchanges source & response points correctly	Minor error in interchange	Builds circuit only	Cannot interchange	No circuit
I-1: CO3 - Vth & Rth Calculation PO2	Finds Vth by open ckt & Rth correctly including dependent source	Minor error in Rth	Finds Vth only	Wrong method	No calculation
PI-1: CO3 - IN & RN Calculation PO2	Finds IN by short ckt & RN=Rth correctly	Minor error in IN	Finds 1 parameter	Wrong method	No calculation
PI-1: CO3 - Condition & Calculation PO2	Proves RL=Rth for DC and ZL=Zth∗ for AC	Proves for DC only	States condition	Wrong condition	No Condition
PI-1: CO3 - Simulation Setup PO3	Simulates RL & RC with AC source. Measures V, I, phase using scope	Simulates 1 circuit	Partial measurement	Cannot measure phase	No simulation
PI-1: CO3 - Parameter Determination PO2	Finds **Z parameters by open circuit test & Y** params by short circui test	Finds 3 parameters correctly	Finds 2 parameters	1parameter	No parameter
PI-1: CO3 - Transient Simulation PO3	Simulates step response. Plots V(t)/I(t) for RL & RC	Simulates 1 circuit	Partial plot	No plot	No simulation

Rubrics for SEE / CIE Test:

- To qualify and become eligible to appear for SEE, in the CIE component, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result & Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output. (3)	Student will be able to run the program but not able to analyze the output. (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

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Programme: B.E. Electrical and Electronics Engineering			
Transducers and Sensors Lab			
Course Code	**1BEEL307B**	Scheme	2025
Type of Course	Ability Enhancement Course Lab	Semester	III
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:(SL:TW)	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2

Course outcome

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

CO1: Explain the operating principles, characteristics, and applications of various sensors and transducers, including LVDT, RTD, strain gauge, LDR, piezoelectric, Hall-effect, capacitive touch, smoke, IR, and pulse-rate sensors.

CO2: Apply transducers and sensors to develop simple real-world engineering systems for monitoring, automation, safety, healthcare, renewable energy, and industrial applications.

CO3: Analyse and compare the characteristics and performance of transducers and sensors including LVDT, RTD, strain gauges, LDRs, piezoelectric sensors, and Hall-effect sensors for engineering measurement applications.

CO4: Design, construct, and test sensor-based measurement and control circuits using capacitive touch sensors, smoke sensors, infrared sensors, and pulse heart-rate sensors.

CO5: Demonstrate professional engineering practices by selecting and using modern tools, conducting experiments safely and ethically, working effectively in teams, documenting and communicating results, considering societal and environmental impacts, and independently acquiring knowledge for sensor-based system development.

List of experiments

(1)Measure displacement using linear variable differential transformer (LVDT) and obtain the voltage versus displacement curve. Determine,
(i)the sensitivity in V/mm (ratio of the change in output voltage to the corresponding change in displacement of the core), and
(ii) resolution (The smallest change in displacement that can be detected by the LVDT in mm, micrometre, or nanometre.).

(2) Measure the change in temperature of a resistor using resistance temperature detector (RTD) using both 3-wire and 4-wire configurations. Compare the results and conclude which configuration provides better accuracy and justify the reason.

(3) Determine the strain of a cantilever beam using strain gauge for quarter bridge, half bridge and full bridge configurations. Compare the results and identify the preferable configuration among the three methods.
Use standard weights such as 100 gram, 250 gram and 500 gram, 1000 gram and their combinations to apply load, at the end of the beam.

(4)Measure the intensity of light incident on a solar panel using light dependent resistor (LDR/ photoresistor module) to optimize the orientation of the solar panel for maximum energy harvesting. Plot a graph sun light of intensity and panel placement angle.

(5) Generate electricity using piezoelectric sensor to glow an LED. Plot a graph of generated voltage versus load. Use standard weights such as 100 gram, 250 gram and 500 gram, 1000 gram and their combinations to apply load.

(6) Measure the flux density in the vicinity of an electromagnet using a Hall effect sensor.

(7) Construct a circuit and control its ON/OFF operation using capacitive touch switch module, such as TTP223 or its equivalent.

(8) Using a suitable smoke, design and implement a smoke alarm system.

(9) Build a circuit using infrared (IR) sensor to avoid train collision by detecting another train on the same track and halting the train operation.

(10) Construct a circuit to measure and record heart rate using pulse heart rate sensor module.

Reference

(1)A Course in Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney, Dhanpat Rai and sons.
(2) Electronic Measurements and Instrumentation, Dr. R.S. Sedha, S. Chand and Company Pvt. Ltd.
(3) Electronic Instrumentation, H S Kalsi, McGraw Hill.
(4)ATL Equipment Manual, Niti Aayog.

Web links and Video Lectures (e-Resources):

https://projecthub.arduino.cc/
https://www.youtube.com/results?search_query=NPTEL+LVDT

3. **https://www.youtube.com/results?search_query=RTD+3+wire+4+wire+connection**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Demonstration-based and hands-on learning.
(ii)Simulation-assisted experimentation.
(iii)Design, testing, and troubleshooting activities.
(iv)Mini-projects and virtual laboratory exercises.
(v) Self-learning through NPTEL, SWAYAM, and other MOOCs.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE Laboratory Report (30 Marks)

Performance Indicator (5 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (5M)	Complete, neat, well-organized with aim, theory, procedure, observations and calculations without errors.	Minor omissions with good presentation.	Adequate write-up with few errors.	Incomplete write-up with several errors.	Very poor or not submitted.
PI-2: Conduction (5M)	Performs experiment independently	Performs with minimal guidance.	Performs with	Performs with significant assistance.	Unable to perform experiment.

	following correct procedure and safety practices.		occasional assistance.		
PI-3: Observation Writing (5M)	Observations recorded accurately, systematically and completely.	Minor recording errors.	Most observations recorded correctly.	Incomplete or inconsistent observations.	Observations missing or incorrect.
PI-4: Output & Analysis (5M)	Results are accurate with complete calculations, graphs and meaningful analysis.	Correct results with minor analytical errors.	Results obtained with limited analysis.	Incorrect /incomplete analysis.	Unable to obtain or analyse results.
PI-5: Team Work (5M)	Excellent collaboration, communication and responsibility throughout the experiment.	Works well with team with minor issues.	Participates adequately.	Limited participation.	Does not cooperate with team.
PI-6: Viva (5M)	Answers all questions confidently with clear conceptual understanding.	Answers most questions correctly.	Answers basic questions.	Limited understanding.	Unable to answer basic questions.

Rubrics for CIE Practical Test (20 Marks)

Performance Indicator (5 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (5M)	Complete and well-organized write-up with no errors.	Minor omissions.	Adequate documentation.	Incomplete documentation.	Poor or missing write-up.
PI-2: Conduction (5M)	Performs experiment independently with correct procedure and safety.	Performs with minimal guidance.	Performs with occasional assistance.	Requires continuous guidance.	Unable to conduct experiment.
PI-3: Output (5M)	Correct readings, calculations and expected results obtained.	Minor errors in output.	Acceptable output with few errors.	Incomplete or inaccurate output.	No meaningful output.
PI-4: Viva (5M)	Excellent conceptual understanding	Good understanding.	Satisfactory understanding.	Limited understanding.	

	with confident answers.				

Rubrics for SEE Practical Examination (50 Marks)

Performance Indicator (10 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (10M)	Complete, accurate and well-presented experiment write-up with all required details.	Minor omissions but well documented.	Adequate documentation with few errors.	Incomplete documentation.	Poor or missing write-up.
PI-2: Selection of Tools & Analysis (10M)	Selects appropriate instruments/tools correctly and performs detailed analysis with proper interpretation.	Correct tool selection with good analysis.	Appropriate tools selected with basic analysis.	Limited understanding of tool selection and analysis.	Incorrect tool selection and unable to analyse results.
PI-3: Conduction (10M)	Performs experiment independently, accurately and safely within allotted time.	Performs with minimal guidance.	Performs satisfactorily with some assistance.	Requires significant assistance.	Unable to complete experiment.
PI-4: Output (10M)	Accurate observations, calculations and expected results with proper graphs/tables wherever applicable.	Minor errors in output.	Acceptable output with limited errors.	Incomplete or inaccurate output.	Incorrect or no output.
PI-5: Viva (10M)	Demonstrates excellent conceptual knowledge, reasoning and application skills.	Good conceptual understanding.	Satisfactory understanding.	Limited conceptual knowledge.	Unable to answer fundamental questions.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

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Programme: B.E. Electrical and Electronics Engineering			
Python Programming			
Course Code	**1BEEL307C**	Scheme	2025
Type of Course	Ability Enhancement Course Lab	Semester	III
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:(SL:TW)	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2

Course outcome

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

CO1: Explain the fundamental concepts of Python programming, including data types, operators, control statements, strings, lists, dictionaries, functions, files, and regular expressions..

CO2: Apply appropriate Python data structures including lists and dictionaries for data storage, processing, and analysis.

CO3: Analyze Python programs by debugging, validating inputs, optimizing logic, processing data structures, and interpreting program outputs for correctness and efficiency.

CO4: Design and implement Python programs involving string manipulation, pattern matching using regular expressions, and file handling operations.

CO5: Demonstrate professional programming practices by utilizing modern development tools, collaborating effectively in teams, communicating technical solutions, adhering to ethical coding practices, managing programming tasks, and engaging in self-directed learning for continuous improvement.

List of experiments

(1) Develop a Python program to simulate Rock-Paper-Scissor Game. The game shall produce output as illustrated with the inputs.

User 1 Input	User 2 Input	Output
Rock	Paper	User 2 (Paper) Wins
Paper	Scissors	User 2 (Scissors) Wins
Scissors	Rock	User 2 (Rock) Wins
Paper	Rock	User 1 (Paper) Wins
Scissors	Paper	User 1 (Scissors) Wins
Rock	Scissors	User 1 (Rock) Wins

Optimize the code to contain only 1 if-else statement.
(Concept Explored: Conditional Statements)

(2) Write a python program to check whether a given number is prime or not.
(Concepts Explored: Looping and Conditional Statements)

(3) Write a Python program to calculate the length of a string without using built in function and determine whether it is a palindrome or not.
(Concepts Explored: Strings, Slicing)

(4) Develop a Python program to accept the scores of students in a department and determine the highest score obtained. The program shall identify the topper score, taking into account the possibility of multiple toppers, and calculate the sum of all scores present in the list.
(Concepts Explored: Python List)

(5) Write a Python function that accepts a sentence from the user and counts the number of

words in the sentence.
(Concepts Explored: String splitting and List)

(6) Write a Python program to store the phone numbers of persons in a dictionary and display the phone number corresponding to a requested person's name.
(Concepts Explored: Dictionary)

(7) Develop a python program to count occurrence of all character's present in each string.
(Concepts Explored: Dictionary get () method)

(8) Develop a python program to copy the contents of only odd-numbered lines from one file to another file.
(Concepts Explored: File Handling)

(9) Design a Python program using Regular expressions to:
(a)Extract Email IDs from a given text.
(b)Validate a user password having, minimum length of 6 characters, and maximum length of 16. The password must have at least one lower-case letter, at least one upper-case letter, at least one numeral (digit) and at least one special symbol (#, @, $, _).
(Concepts Explored: Regular Expression)

(10) Write a Python program to accept a list of integers from the user and separate them into even and odd numbers. Display the count and sum of even numbers and odd numbers separately.
(Concepts Explored: Lists, Looping, and Conditional Statements)

Reference books

(i) Computing with Python-An introduction to Python for Science and Engineering, Claus Fuherer, et al., Pearson.
(ii) Introduction to Python Programming, Udayan Das, et, el., Openstax.
(iii) Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University Press, New Delhi.
(iv) Intro to Python, Paul Deitel, Harvey Deitel, Pearson.

Web links and Video Lectures (e-Resources):

1. **https://docs.python.org/3/tutorial/?utm_source**
2. **https://www.geeksforgeeks.org/python/python-programming-language-tutorial/?utm_source**
3. **https://www.w3schools.com/python/?utm_source**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Hands-on programming practice through guided coding exercises and laboratory sessions.
(ii)Problem-based learning involving algorithm development and computational problem-solving.
(iii)Interactive learning through code debugging, testing, and performance evaluation of programs.
(iv)Collaborative learning through pair programming, peer review, and group-based coding activities.
(v)Application-oriented learning using real-world examples involving data processing, file handling, text processing, and pattern matching.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE Record Evaluation (30 Marks)

Performance Indicator	5 - Superior	4 - Good	3 - Fair	2 - Needs Improvement	1 - Unacceptable
PI-1: Correct Program Write-up (5M)	Complete algorithm, flow, syntax, logic and documentation are correct without errors.	Minor omissions in write-up but program logic is correct.	Program write-up is partially correct with some logical mistakes.	Incomplete write-up with major errors.	No meaningful program write-up.
PI-2: Run the Program with Zero Errors and Zero Warnings (5M)	Compiles and executes successfully without errors or warnings on first attempt.	Executes with one minor correction.	Executes after multiple corrections.	Frequent compilation/runtime errors requiring major assistance.	Unable to compile or execute the program.
PI-3: Observation Writing (5M)	Observations are complete, accurate and technically justified.	Observations are correct with minor omissions.	Basic observations recorded with limited explanation.	Incomplete or inaccurate observations.	Observations not recorded.
PI-4: Output and Analysis (5M)	Output is correct and thoroughly analysed with proper justification.	Correct output with adequate analysis.	Output is mostly correct with limited analysis.	Incorrect output or poor analysis.	No output or analysis.
PI-5: Team Work (5M)	Excellent collaboration and contribution.	Works effectively with team members.	Participates satisfactorily.	Limited participation.	Does not cooperate.
PI-6: Viva Voce (5M)	Answers all questions confidently with complete conceptual understanding.	Answers most questions correctly.	Answers basic questions with partial understanding.	Answers few questions correctly.	Unable to answer basic questions.

Rubrics for CIE Practical Test (20 Marks)

Performance Indicator	5 - Superior	4 - Good	3 - Fair	2 - Needs Improvement	1 - Unacceptable
PI-1: Program Write-up (5M)	Program design, algorithm and logic are complete and correct.	Minor omissions.	Basic logic with few mistakes.	Incomplete design.	No meaningful write-up.
PI-2: Run the Program with Zero Errors and Zero Warnings (5M)	Executes successfully without errors or warnings.	Executes after one minor correction.	Executes after several corrections.	Frequent errors requiring assistance.	Unable to execute.
PI-3: Output (5M)	Correct output for all test cases.	Correct output for most cases.	Correct output for basic cases.	Partially correct output.	No valid output.
PI-4: Viva Voce (5M)	Excellent understanding.	Good understanding	Fair understanding	Limited understanding.	Unable to explain.

Rubrics for SEE Practical Examination (50 Marks)

Performance Indicator	5 - Superior	4 - Good	3 - Fair	2 - Needs Improvement	1 - Unacceptable
PI-1: Program Write-up (10M)	Complete, correct and well organized.	Minor omissions.	Acceptable with some errors.	Incomplete.	No meaningful write-up.
PI-2: Software Setup (10M)	Correct IDE/project setup independently.	Minor assistance.	Moderate guidance.	Major assistance.	Unable to set up.
PI-3: Run the Program with Zero Errors and Zero Warnings (10M)	Runs successfully without errors or warnings.	Runs after one correction.	Runs after multiple corrections.	Frequent errors.	Unable to execute.
PI-4: Output (10M)	Accurate output for all test cases.	Correct for most cases.	Correct for basic cases.	Partially correct.	No valid output.
PI-5: Viva Voce (10M)	Excellent conceptual knowledge.	Good understanding.	Fair understanding .	Limited knowledge.	Unable to answer.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

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Programme: B.E. Electrical and Electronics Engineering

Digital Electronic Circuits Lab

Course Code	**1BEEL307D**	Scheme	2025
Type of Course	Ability Enhancement Course Lab	Semester	III
Teaching Hours/Week (L :T : P)	0:0 :2	CIE Marks	50
Total Hours of Pedagogy L :T:P:(SL:TW)	0:0:28:2	SEE Marks	50
Credits	**1**	Total Marks	100
Type of Examination	Practical	Exam Hours	3

Course Outcomes

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

CO1: Verify the operation of basic logic gates, universal gates, Boolean algebra theorems, and flip-flops through truth tables and digital logic circuits.

CO2: Construct and test combinational digital circuits such as adders, subtractors, code converters, and arithmetic circuits using logic gates and standard digital ICs.

CO3: Analyze the performance of combinational and sequential digital circuits by interpreting experimental results, identifying logical errors, and validating circuit operation against theoretical expectations.

CO4: Design, develop, troubleshoot, and validate digital electronic systems using appropriate hardware, software, and laboratory practices while working effectively in teams and communicating technical findings in accordance with engineering and professional practices.

List of experiments

(1) Verify Truth Table of Logic Gates AND, OR, NAND, NOR, EX-OR, EX-NOR, NOT, and Buffer gates, and demonstrate the use of the universal NAND gate.

(2) Construct the logic circuit to simplify a Boolean function and verify De Morgan's theorem for 2 variables.

(3) Realize half/full adder and half subtractor, and full subtractor circuits using logic gates.

(4) Realize a 4-bit parallel adder/Subtractors using IC 7483 and perform BCD to Excess-3 code conversion and Vice - Versa.

(5) Realize of Binary to Gray code conversion and Gray-to-Binary code conversion.

(6) Design, implement, and test Ring counter and Johnson counter circuits.

(7) Design and investigate the operation of 4-bit shift registers with parallel loading.

(8) Design, implement, and testing a Sequence generator.

(9) Realize 3-bit counters as a sequential circuit and design MOD – N counters using ICs 7476, 7490, 74192.

(10) Verify the logic operation of RS and JK flip-flops and obtain their truth tables.

Reference Book:

((i)) Digital Principles and Design, Donald D. Givone, McGraw Hill,2002.
(ii) Digital Design, Morris Mano, Prentice Hall of India, Third Edition.
(iii) Digital Logic Applications and Design, John M Yarbrough, Thomson Learning, 2001.
(iv) Fundamentals of logic design, Charles H Roth,Jr, Cengage Learning. Fifth Edition.
(v) Digital Systems Design, A Nagoor Kini, CBS Publishers and Distributors, 2026.

Web links and Video Lectures (e-Resources)

1. **https://vlab.co.in/**
2. **https://circuitverse.org/**
3. **https://nptel.ac.in/courses/108105132**
4. **https://www.youtube.com/watch?v=X7M3rUxUpOc&list=PLbRMhDVUMngePP5JcezxImF-FzOC9wstz**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Hands-on experimental learning through implementation and testing of digital logic circuits using ICs and laboratory hardware.

(ii)Design-based learning involving the realization and verification of combinational and sequential logic circuits.

(iii)Problem-solving learning through logic simplification, code conversion, and counter design exercises.

(iv)Simulation-assisted learning for analysis, verification, and troubleshooting of digital electronic circuits.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE Laboratory Report (30 Marks)

Performance Indicator (5 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (5M)	Complete, neat, well-organized with aim, theory, procedure, observations and calculations without errors.	Minor omissions with good presentation.	Adequate write-up with few errors.	Incomplete write-up with several errors.	Very poor or not submitted.
PI-2: Conduction (5M)	Performs experiment independently following correct procedure and safety practices.	Performs with minimal guidance.	Performs with occasional assistance.	Performs with significant assistance.	Unable to perform experiment.
PI-3: Observation Writing (5M)	Observations recorded accurately, systematically and completely.	Minor recording errors.	Most observations recorded correctly.	Incomplete or inconsistent observations.	Observations missing or incorrect.
PI-4: Output & Analysis (5M)	Results are accurate with complete calculations, graphs and meaningful analysis.	Correct results with minor analytical errors.	Results obtained with limited analysis.	Incorrect/incomplete analysis.	Unable to obtain or analyse results.

PI-5: Team Work (5M)	Excellent collaboration, communication and responsibility throughout the experiment.	Works well with team with minor issues.	Participates adequately.	Limited participation.	Does not cooperate with team.
PI**-6: Viva (5M)**	Answers all questions confidently with clear conceptual understanding.	Answers most questions correctly.	Answers basic questions.	Limited understanding.	Unable to answer basic questions.

Rubrics for CIE Practical Test (20 Marks)

Performance Indicator (5 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (5M)	Complete and well-organized write-up with no errors.	Minor omissions.	Adequate documentation.	Incomplete documentation.	Poor or missing write-up.
PI-2: Conduction (5M)	Performs experiment independently with correct procedure and safety.	Performs with minimal guidance.	Performs with occasional assistance.	Requires continuous guidance.	Unable to conduct experiment.
PI-3: Output (5M)	Correct readings, calculations and expected results obtained.	Minor errors in output.	Acceptable output with few errors.	Incomplete or inaccurate output.	No meaningful output.
PI-4: Viva (5M)	Excellent conceptual understanding with confident answers.	Good understanding.	Satisfactory understanding.	Limited understanding.	

Rubrics for SEE Practical Examination (50 Marks)

Performance Indicator (10 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (10M)	Complete, accurate and well-presented	Minor omissions but	Adequate documentation	Incomplete documentation.	Poor or missing write-up.

	experiment write-up with all required details.	well documented.	with few errors.		
PI-2: Selection of Tools & Analysis (10M)	Selects appropriate instruments/ tools correctly and performs detailed analysis with proper interpretation.	Correct tool selection with good analysis.	Appropriate tools selected with basic analysis.	Limited understanding of tool selection and analysis.	Incorrect tool selection and unable to analyse results.
PI-3: Conduction (10M)	Performs experiment independently, accurately and safely within allotted time.	Performs with minimal guidance.	Performs satisfactorily with some assistance.	Requires significant assistance.	Unable to complete experiment.
PI-4: Output (10M)	Accurate observations, calculations and expected results with proper graphs/tables wherever applicable.	Minor errors in output.	Acceptable output with limited errors.	Incomplete or inaccurate output.	Incorrect or no output.
PI-5: Viva (10M)	Demonstrates excellent conceptual knowledge, reasoning and application skills.	Good conceptual understanding.	Satisfactory understanding.	Limited conceptual knowledge.	Unable to answer fundamental questions.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

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Programme: B.E. Electrical and Electronics Engineering			
Community Project (Project Based Learning) Societal Project [Common to all disciplines of Engineering]			
Course Code	**1BCP308**	Scheme	2025
Type of Course	SDC	Semester	III
Teaching Hours/Week (L :T : P)	(0:0:2)	CIE Marks	50
Total Hours of Pedagogy CI(L :T):LI(P):SL:TW	30 (0:0:28:2)	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	02

Course objective:

Rapid urbanisation, population growth, environmental concerns, energy demand, water scarcity, waste management, transportation issues and rural development challenges have created practical problems affecting communities and public welfare. This course aims to integrate technical knowledge, field exposure and societal engagement so that students identify real community issues, frame problem statements and attempt appropriate, feasible and sustainable engineering responses within the scope of a one-semester project.

Course outcome (Course Skill Set):

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

1. **CO1 (L2 – Understand):** Identify and analyse societal problems through field interaction and technical assessment.
2. **CO2 (L3 – Apply):** Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.
3. **CO3 (L4 – Analyse):** Formulate feasible engineering problem statements and solutions considering practical constraints and sustainability aspects.
4. **CO4 (L3 – Apply):** Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.
5. **CO5 (L4 – Analyse):** Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.
6. **CO6 (L5 – Evaluate):** Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.

Restrictions and professional conduct:

Community / Societal Projects shall remain **academic, socially responsible, technically focused, and politically neutral**. Students and faculty shall maintain professionalism, ethical conduct, public respect and institutional integrity while interacting with communities, public groups, organisations and stakeholders.

Students and faculty **shall avoid** the following during project execution:

- Association with political party activities, campaigns or propaganda.
- Participation in activities that may disturb communal harmony, public order or institutional reputation.
- Use of the project platform for personal, political, ideological or commercial promotion.
- Disrespectful, discriminatory or unethical interaction with community members or stakeholders.

Projects must also recognise constraints related to **cost, resources, environment and safety, and stakeholder behaviour/cooperation/acceptance** when planning and implementing activities.

Sustainable Development Goals

The faculty shall encourage students to undertake community projects that align with and contribute towards satisfying the National Board of Accreditation (NBA) Criterion 3.6, namely, Evidence of Addressing Sustainable Development Goals (SDGs), which is a major emphasis of the United Nations (UN). The Sustainable Development Goals (SDGs) are illustrated in the figure shown below:

SET OF PROJECT ACTIVITIES (TW/SL = 30 HOURS)

Methods for project identification:

Students may identify the project topic using one or more of the following methods:

- Interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.
- Review of issues highlighted in print and electronic media, and social networks (WhatsApp, Facebook, X, Instagram, etc.).
- After selecting a broad topic, students shall collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and then define the problem statement and objectives clearly.

List of Project Topics and Engineering Outcomes:

The following structured sequence of activities is to be carried out during the semester:

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
1	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12
2	Waste management and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow with measurable reduction in mixed waste.	PO2, PO3, PO4, PO6, PO8, PO10	SDG 11, SDG 12, SDG 13

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
3	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate tracking and maintenance schedule for saplings.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
4	Biogas generation and power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 11, SDG 12
5	DPR for solar power rural plant	Prepare a DPR with load assessment, panel sizing, cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 11
6	DPR for electrification of village/tribal community	Map unserved/underserved households, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 7, SDG 9, SDG 10
7	DPR for rural drainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handling capacity and flood-risk reduction.	PO1, PO2, PO3, PO4, PO6, PO10	SDG 6, SDG 9, SDG 11
8	Sustainability and environmental health projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2, PO3, PO4, PO6, PO7, PO8	SDG 3, SDG 6, SDG 11, SDG 12
9	Plastic free campaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
10	Health and nutrition awareness	Conduct baseline and post-program awareness survey and document improvement in awareness score or adoption of healthier practices.	PO2, PO6, PO7, PO8, PO9, PO10	SDG 2, SDG 3, SDG 11
11	Societal projects involving health wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9, PO10	SDG 3, SDG 11, SDG 17
12	Air quality monitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6, PO10	SDG 3, SDG 11, SDG 13
13	Plastic waste reduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic waste generation or littering.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
14	Urban greening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
15	Smart agriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or crop support.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 9
16	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12
17	Youth mentoring programmes	Deliver a structured mentoring activity and measure participation, engagement, and skill/awareness improvement.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10, SDG 17
18	Adult education	Conduct learner-needs assessment, prepare instructional content, and measure improvement in basic literacy or numeracy indicators.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10, SDG 17
19	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, SDG 12
20	Human rights awareness with legal systems	Prepare and deliver an awareness module and assess increase in legal awareness and access-to-rights understanding.	PO6, PO7, PO8, PO9, PO10	SDG 5, SDG 10, SDG 16
21	House tax collection through digital media	Develop a simple digital workflow or awareness support and measure improvement in compliance, convenience, or response time.	PO2, PO3, PO4, PO5, PO10, PO11	SDG 9, SDG 11, SDG 16
22	Use of application / application program	Build or demonstrate a useful community app and measure usability, adoption, or efficiency improvement.	PO1, PO3, PO4, PO5, PO9, PO10	SDG 9, SDG 11, SDG 17
23	Creation of Panchayat library	Plan the library model, catalogue resources, and measure usage, accessibility, or participation outcomes.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10, SDG 11, SDG 17

Suggested Learning Resources:

Textbooks:

1. **Phadke, N. D**. Community Engagement and Social Innovation. 1st ed., Oxford University Press, New Delhi.
2. **Garg, N. R**. Project-Based Learning in Engineering Education. 1st ed., Pearson India Education Services, Noida.
3. **Gupta, A. and P. Singh.** Service Learning and Community Projects. 1st ed., McGraw-Hill Education (India), New Delhi.
4. **Wilson, G.** Practical Guide to Community Development Projects. 2nd ed., Routledge, London.

Reference books:

1. NPTEL courses on Project-Based Learning and Social Innovation.
2. SWAYAM courses on community engagement and sustainability.
3. UN Sustainable Development Goals portal: https://sdgs.un.org
4. MyGov India and local civic body portals for community initiatives.
5. YouTube resources on design thinking, social innovation, and community service learning.
6. NGO and government field-action case studies related to sanitation, water, health, education, and environment.

Web links and Video Lectures (e-Resources):

1. NPTEL courses on Engineering Geology (IIT Roorkee, IIT Kharagpur).
2. NPTEL courses on Soil Mechanics and Foundation Engineering (IIT Delhi, IIT Bombay).
3. Virtual Labs – Geotechnical Engineering Virtual Lab (IIT Kanpur): https://vlab.co.in
4. Geological Survey of India (GSI) – Maps, reports, and publications: https://www.gsi.gov.in
5. YouTube channels: Civil Engineering Essentials, The Engineering Classroom (soil mechanics experiments).
6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards

Teaching Learning Process:

The suggested TLP for Community / Societal Project is as follows;

Week / Phase	Teaching–Learning Activity	Faculty Role	Student Activity	Output / Evidence
1	Course introduction, objectives, ethics, conduct, and assessment briefing	Explain course scope, rules, rubrics, and expected deliverables	Understand course requirements and form teams	Team list, course plan
2	Community problem identification and topic selection	Guide topic framing and feasibility	Identify local issues through discussion and observation	Shortlisted project topic
3	Stakeholder interaction and preliminary survey	Demonstrate survey methods and stakeholder engagement	Collect initial data from community/users	Survey notes, interview record
4	Problem statement and objective	Review and refine problem statement	Prepare problem statement, scope, and	Approved problem statement
	formulation		objectives	
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary

Week / Phase	Teaching–Learning Activity	Faculty Role	Student Activity	Output / Evidence
6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Work plan / Gantt chart
7	Feasibility analysis and solution brainstorming	Check technical feasibility and practicality	Generate possible engineering solutions	Solution alternatives sheet
8	Selection of final solution and design approach	Review final concept and design logic	Finalize concept, methods, and expected outcome	Concept note / design outline
9	Data processing / calculations / sizing / mapping	Support computations and technical review	Analyze data, perform calculations, prepare maps/charts	Technical analysis sheet
10	Prototype / model / audit / DPR / app development	Monitor progress and correct technical issues	Develop the selected output	Working model / draft DPR / map / app
11	Testing, refinement, and implementation planning	Evaluate technical correctness and improvements	Test prototype or validate proposal with users	Test results / revised output
12	Field implementation / demonstration / awareness activity	Facilitate community interaction and documentation	Conduct implementation or demonstration	Photos, attendance, implementation record
13	Documentation of outcomes, feedback, and impact	Review report structure and completeness	Compile findings, stakeholder feedback, and observations	Draft report
14	Presentation preparation and viva practice	Conduct mock presentation and feedback	Prepare slides/poster and rehearse	Presentation deck
15	Final presentation, submission, and reflection	Evaluate performance using rubrics	Present project, submit report, reflect on learning	Final report, presentation, viva

Assessment structure:

A. Continuous Internal Evaluation (CIE) – 50 marks

- Students, in batches of 3–4, shall undertake at least one project (or a combination of two related activities) aiming, as far as possible, at a logical implemented or implementable outcome.
- CIE will be conducted by a departmental committee (HoD/nominee, guide and one senior faculty) using the following rubrics totalling 50 marks:

CIE pass requirement:

- A student shall secure a minimum of 20 marks out of 50 in CIE to become eligible to appear for SEE.

- Students who fail to earn the required CIE marks may be given additional opportunities before closure of the semester; no re-doing of CIE is permitted after the end of the semester.

B. Semester End Examination (SEE) – 100 marks (scaled to 50)

- Examination duration: 2 hours.
- Maximum examination marks: 100 (entered as 100 in the VTU portal; the ITI-SMU module automatically scales 100 → 50 for result processing).
- The SEE shall be conducted batch-wise by a committee of three faculty: project guide, one faculty from the same department and one from a different department.

SEE pass requirement and overall passing rule:

- For a pass in SEE, a student shall secure minimum 35 marks out of 100.
- For declaration of a pass grade, the sum of CIE marks (out of 50) and scaled SEE marks (out of 50) shall be ≥ 40; otherwise, the student is awarded grade F (Fail).

CIE Rubric — Continuous Internal Evaluation (Total 50 marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & Relevance to society/industry /community	8	Problem is clearly identified with strong evidence of societal relevance and well-defined scope.	Problem is relevant and scope is clear with adequate supporting evidence.	Problem defined but justification or evidence is weak.	Problem unclear or not relevant; little/no supporting evidence.
Formation of problem statement; Engineering approach, innovation & feasibility	10	Problem statement is precise; approach is sound, innovative and clearly feasible.	Problem statement adequate; approach feasible with minor gaps.	Problem statement partial; approach feasibility is marginal.	Problem statement missing or approach not feasible.
Interaction with stakeholders; Data collection, analysis & interpretation	8	Thorough stakeholder engagement; data collection is comprehensive; analysis is well-interpreted.	Good engagement; data and analysis adequate with minor gaps.	Limited engagement; data incomplete and analysis superficial.	Little/no stakeholder contact; insufficient or no data/ analysis.
Project documentation; Clarity, organization & problem-solving demonstrated	10	Documentation is complete, well-organized, analytical, and shows strong problem-solving.	Documentation complete and clear with some analytical content.	Documentation basic with omissions; problem-solving limited.	Documentation missing/poorly organized; no clear problem-solving .
Communication & Presentation skills	6	Presentation is confident, structured, and answers queries fully; visuals effective.	Presentation clear and satisfactory; responds to most queries.	Presentation acceptable but lacks clarity or confidence; weak responses.	Presentation poor or absent; unable to respond.
Contribution & Benefit tosociety (impact, sustainability)	8	Clear, demonstrable societal benefit and sustainability; realistic path to implementation.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear societal benefit; sustainability not well addressed.	No evident benefit or sustainability; project not community-oriented.

Notes for CIE rubric:

- Minimum CIE pass requirement: 20/50 to be eligible for SEE. [Use departmental committee (HoD/guide + senior faculty) to apply the rubric and record marks.]

SEE Rubric — Semester End Examination (Enter marks out of 100; scaled to 50 later):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & Relevance to society/industry/ community	16	Problem and relevance are articulated clearly with strong evidence and context.	Problem relevance clear with reasonable evidence.	Problem stated but evidence/ context weak.	Problem poorly defined or irrelevant.
Formation of problem statement; Engineering approach, innovation & feasibility	20	Problem statement is precise; approach demonstrates engineering depth, novelty and feasibility.	Approach is technically sound and feasible with minor limitations.	Approach basic; limited technical depth or feasibility concerns.	No viable engineering approach or infeasible plan.
Interaction with stakeholders; Data collection, analysis & interpretation	16	Excellent stakeholder engagement; rigorous data collection and insightful analysis.	Good engagement and acceptable analysis.	Superficial data collection and limited analysis.	Inadequate or no data; poor analysis.
Project documentation; Clarity, technical rigor & problem-solving demonstrated	20	Report is comprehensive, technically rigorous, and demonstrates systematic problem-solving.	Report is complete and technically correct with minor gaps.	Report lacks technical depth or has notable omissions.	Report missing key elements or technically incorrect.
Communication, Presentation & Viva-voce responses	12	Candidate presents expertly, defends work persuasively and answers all queries correctly.	Good presentation and satisfactory answers to most queries.	Presentation adequate but fails to answer some technical questions.	Poor presentation and unable to defend work.
Contribution & Benefit to society; Impact assessment & sustainability	16	Clear, evidence-based assessment of social impact and Sustainability with scaling recommendations.	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impactor sustainability.	No coherent assessment of impact or sustainability.

SEE pass rule:

- Student must secure at least 35/100 in SEE itself to be eligible for pass consideration.
- Final passing is based on CIE (out of 50) + SEE (scaled to 50) >= 40. Otherwise, grade F (Fail) is awarded.

Suggested implementation notes (for BoS / exam committees):

- Use numerical scores from the rubric and keep brief evaluator comments for each criterion.
- For team projects: record individual contribution within the documentation and adjust individual marks using a peer-evaluation sheet or guide's assessment.
- Maintain evidence (field notes, photos, questionnaires, DPRs, reports) as annexures for SEE moderation.
- Use standardized score sheet (spreadsheet) mapping rubric items to columns for easy aggregation and archival.

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Programme: B.E. Electrical and Electronics Engineering			
Additional Mathematics -I (Common to all Branches)			
Course Code:	**1BMATDIP310**	CIE Marks	50
Course Type	Theory	MCQ online exam Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)	3:0:0:0	Exam Hours	-
Total Hours of Pedagogy	42 hours	Credits	00 (PP)

Course objectives (COS): The goal of the course **1BMATDIP310 Additional Mathematics -I (Common to all Branches)** is to

CO1: **Provide** the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists

CO2: Apply the knowledge of the co-ordinate system to analyze the polar co-ordinate system.

CO3: Familiarize the importance of calculus associated with one variable and multivariable for all branches of the engineering.

CO4: Analyze the importance of the integral calculus and their application to real-world problems.

CO5: Emphasize the knowledge of the vector calculus to all branches of engineering.

CO6: Develop the knowledge of Linear Algebra to solve the system of equations.

Module-1: Polar Curves and Curvature (8 hours)

Polar coordinates, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Indeterminate forms: L'Hospital's rule ($\frac{\infty}{\infty}, \infty - \infty, 0^0, 1^\infty$).

(RBT Levels: L1, L2 and L3)

Module-2: Partial Differentiation (9 hours)

Introduction: Partial derivatives, total derivative - differentiation of composite functions, Jacobian and problems.

Taylor's and Maclaurin's series expansion for one variable (Statement only) – problems

(RBT Levels: L1, L2 and L3)

Module-3: Integral Calculus (9 hours)

Statement of reduction formulae for $\sin^n(x), \cos^n(x)$ and $\sin^m(x)\cos^n(x)$ and illustrative problems. Evaluation of double integrals and triple integrals-Simple examples.

Applications: Area of the region.

(RBT Levels: L1, L2 and L3)

Module-4: Vector Calculus (8 hours)

Differentiation of vector functions: Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence and Curl, Solenoidal and irrotational vector fields-Problems.

(RBT Levels: L1, L2 and L3)

Module-5: Linear Algebra (8 hours)

Introduction to linear algebra:

Elementary row transformation of a matrix, Rank of a matrix. Consistency and Solution of system of linear equations - Gauss-elimination method, Gauss Siedel method. Eigenvalues and Eigenvectors (2×2).

(RBT Levels: L1, L2 and L3).

Suggested Learning

Resources Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2021
2. Gilbert Strang, Linear Algebra and its Applications, Cengage Publications, 4th Ed., 2022.
3. Erwin Kreyszig . Advanced Engineering Mathematics, wiley

Reference Books:

1. H K Das and Rajaneesh Varma, Higher Engineering Mathematics, S. Chand.
2. B. V. Ramana, Higher Engineering Mathematics, McGraw Hill.
3. Mangey Ram, Mathematics in Engineering Sciences, CRC Press
4. N. P. Bali, Manish Goyal - A Textbook of Engineering Mathematics, Laxmi Publications
5. David Poole, Linear Algebra, Cengage Learning India Pvt Ltd.

Web links and e-Resources:

- NPTEL (National Programme on Technology Enhanced Learning) – Mathematics: https://nptel.ac.in/..
- SWAYAM learning modules on Engineering mathematics .
- https://www.coursera.org/ Mathematics for Engineering Specialization

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- ICT-Enabled Teaching.

Assessment Structure:

For courses offered by the Department of Mathematics, the Continuous Internal Evaluation (CIE) shall be conducted by the concerned course teacher. The CIE may comprise tests, assignments, quizzes, seminars, or other academic activities, as decided by the concerned teacher. The distribution of marks among these activities shall be determined by the course teacher. The total marks awarded for all CIE activities shall be 100 marks.

The concerned teacher shall upload the CIE marks to the VTU web portal whenever notified by the University.

Online Mode of Offering for 1BMATDIP301 and 1BMATDIP401

The lecture sessions for 1BMATDIP301 shall also be made available through the vtu.online.ac.in platform.

1. If all the students admitted to the 3rd and 4th semesters of a college opt to pursue these courses in online mode, the entire course shall be offered online. In such cases, the Centre for Online Education, Mysuru shall

conduct the **Continuous Internal Evaluation (CIE)** for **100 marks** and submit the CIE marks to the University, with a copy to the concerned college.

2. Within the **same college/department**, all admitted students shall follow a single mode of learning for these courses. A situation where a part of the students opts for the online mode and the remaining students opt for the offline mode **shall not be permitted**.
3. A college intending to offer these courses through the online mode shall submit the **list of eligible students** to the Registrar, Visvesvaraya Technological University (VTU), Belagavi, for approval. Only after obtaining the approval of the University shall the students be permitted to enrol for the online course through the vtu.online.ac.in platform**.**

Notwithstanding the above, a student is considered to have **passed the course,** provided the total of **CIE online** examination is at least 40 out of 100 marks.

B.E. in Electrical and Electronics Engineering
Scheme of Teaching and Examinations 2025
Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Effective from the academic year 2025-26)

IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching and Learning Scheme					Examination				Credits
					Classroom Instruction (CI) hours		Laboratory Instruction (LI) hours	Term work & self -learning in hours	Teaching - Learning hours per semester = CI +LI+TW+SL	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	TW+SL						
1	PCC	1BEE401	Electric Motors	EEE	42	0	0	48	90	3	50	50	100	3
2	IPCC	1BEE402	Microcontroller	EEE	42	0	28	50	120	3	50	50	100	4
3	PCC	1BEE403	Field Theory	EEE	42	28	0	50	120	3	50	50	100	4
4	PCC	1BEE404	Transmission and Distribution	EEE	42	0	0	48	90	3	50	50	100	3
5	PCCL	1BEEL405	Electric Motors Lab	EEE	0	0	28	02	30	2	50	50	100	1
6	AEC	1BEEL406	Ability Enhancement Course Laboratory	EEE	0	0	28	02	30	2	50	50	100	1
7	BSC	1BEE407	Biology for Electrical Engineers	EEE	28	0	0	32	60	3	50	50	100	2
8	SDC	1BEP408	Environmental Science Project	EEE	0	0	0	30	30	3	50	50	100	1
9	PCC	1BEE409	Electric Power Generation and Economics	EEE	42	0	0	48	90	3	50	50	100	3
10	NCMC	1BNSK409	National Service Scheme (NSS)	Concerned campus Staff. (CIE : Viva - Voce and demonstrations	NSS coordinator		The teaching–learning methodology shall be aligned with the specific nature of each subject, viz., NSS, PE, Yoga, and Music.	30	30	--	100	---	100	PP
		1BPEK409	Physical Education (PE) (Sports and Athletics)		Physical Education Director									
		1BYOK409	Yoga		Yoga Teacher									
		1BMUS409	Music		Music Teacher									
Total (In case of regular students)									**690**		**550**	**450**	**1000**	**22**
11	NCMC	1BMATDIP410	Additional Mathematics -II course for Lateral Entry Students	Assessment Structure as mentioned in the syllabus	42	0	0	48	90	--	100	--	100	PP
Total (In case of lateral-entry students not exempted from studying 1BMATDIP310)									**780**		**650**	**450**	**1100**	22

Ability Enhancement Course (Laboratory)

1BEEL406A	Arduino, ARM & Raspberry PI Based Projects	1BEEL406C	MATLAB (Matrix Laboratory)
1BEEL406B	Java Programming	1BEEL406D	Electrical Measurements Lab

Programme: B.E. Electrical and Electronics Engineering			
Electric Motors			
Course Code	**1BEE401**	Scheme	2025
Type of Course	Professional Core Course	Semester	IV
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/(SL&TW):	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Objectives:

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

CO1: Explain the construction, operating principles, characteristics, and performance evaluation of DC motors and three-phase induction motors.

CO2: Analyse the performance of three-phase induction motors using equivalent circuits, phasor diagrams, circle diagrams, and evaluate operating characteristics.

CO3: Apply appropriate starting methods and speed-control techniques for DC motors and three-phase induction motors, and select suitable motors for industrial and commercial applications.

CO4: Explain the construction, operating characteristics, excitation control, and applications of single-phase induction motors, synchronous motors, and synchronous condensers.

CO5: Describe the construction, working principles, characteristics, and applications of special-purpose motors.

Module-1

DC Motors: Construction and working principle. Back E.M.F and its significance, Torque equation, Classification, Armature reaction, commutation and its associated problems, Characteristics of separately excited, shunt, series and compound motors, Losses in DC motors, efficiency, condition for maximum efficiency. Speed control of shunt motor, Application of motors. Testing of DC motors-Swinburne's test, Hopkinson's test, merits and demerits of tests, Field's test for series motors. Numerical Problems.

Number of Hours: 09

Module-2

Three Phase Induction Motors: Concept and generation of rotating magnetic field, Principle of operation, constructional features of squirrel-cage and slip-ring motors. Slip and its significance, Rotor frequency, Rotor emf, current, air gap power, and electromagnetic torque, and shaft torque. Torque-slip characteristic covering motoring, generating and braking regions of operation, applications. Numerical Problems.

Number of Hours:09

Module-3

Performance of Three-Phase Induction Motor: Equivalent circuit, Phasor diagram, Induction motor on no-load and on load, losses, efficiency, Operating characteristics of the motor, No-load and blocked rotor tests. Predetermination of motor performance from equivalent circuit and circle diagram. Cogging and crawling. Numerical Problems.

High torque rotors-double cage and deep rotor bars. Induction motor working as induction generator, construction and working of doubly fed induction generator.

Number of Hours:08

Module-4

Starting and Speed Control of Three-Phase Induction Motors: Necessity of starter. Direct online, Star-Delta, and autotransformer starting. Rotor resistance starting of a wound rotor motor. Speed control by frequency. Numerical Problems.

Single-Phase Induction Motor: Double revolving field theory and principle of operation. Construction and operation of split-phase, capacitor start, capacitor run and shaded pole motors. Comparison of single-phase motors and applications.

Number of Hours:08

Module-5

Synchronous Motor: Principle of operation, Equivalent circuit and phasor diagrams, Power developed, torque and torque angle, effect of changing excitation on constant load, effect of increased load with constant excitation, V and inverted V curves. Synchronous condenser,

Special Type Motors: Construction and principle of operation of universal motor, AC servomotor, linear induction motor, permanent magnet synchronous motor (PMSM), switched reluctance motor (SRM) and brushless DC motor (BLDC).

Number of Hours:08

Textbooks:

(i)Electric Machines, D. P. Kothari, I. J. Nagrath, McGraw Hill, 4th edition, 2011.
(ii)Theory of Alternating Current Machines, Alexander Langsdorf, McGraw Hill, 2nd Edition, 2001.
(iii)Electric Machines, Ashfaq Hussain, Dhanpat Rai & Co, 2nd Edition, 2013.
(iv) Theory and Performance of Electrical Machines, J. B. Gupta, Katson Books,2020.
(v) Electrical Machinery, P.S. Bimbhra, Khanna Publishing House, 2024.

Reference Books:

(i)Electrical Machines, Drives and Power systems, Theodore Wildi, Pearson, 6th Edition, 2014
(ii)Electrical Machines, M.V. Deshpande, PHI Learning, 2013
(iii)Electric Machinery and Transformers, Bhag S. Guru at el, Oxford University Press, 3rd Edition, 2012
(iv)Electric Machinery and Transformers, Irving Kosow, Pearson, 2nd Edition, 2012
(v)Principles of Electric Machines and power Electronic, P.C. Sen, Wiley, 2nd Edition, 2013
(vi)Electrical Machines, R.K. Srivastava, Cengage Learning, 2nd Edition, 2013

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Interactive learning through analysis of motor characteristics.
(ii)Problem-solving based learning.
(iii)Simulation-assisted learning for visualization of motor operation, starting methods, speed control, and performance characteristics.
(iv)Application-oriented learning through case studies. .
(v)Activity-based learning.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the

combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.
In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.
It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Group Activity-Problem based Learning (Quiz, Case study, Industrial visit, simulation activity, technical poster presentation, expert talk, etc..)	15
2.	Self-Learning- (Open Book test/Assignments /Video Based Learning/Virtual Lab. etc)	10

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Activity	Performance Indicator	Excellent	Very Good	Good	Fair	Needs Improvement
Group Activity (15 Marks)	PO2- Problem Analysis, PO5- Engineering tool usage, PO8- Individual and Collaborative Team Work, PO9- Communication (15)	Performs the assigned task clearly, accurately, and confidently with a thorough understanding of the concepts. (14–12)	Performs the assigned task accurately with a good understanding of the concepts. (11–9)	Performs the task with adequate understanding and completes most requirements. (8–6)	Performs the task with limited understanding. (5–3)	Performs the task with minimal understanding. (2–1)
Self-Learning (10 Marks)	PO1 – Engineering Knowledge, PO2 – Problem Analysis, PO11 – Life-long Learning (10)	Completes the assignment/ open book test accurately neatly presented, and submitted/written on time. (9-8)	Completes the assignment neatly presented, with only minor errors or omissions. Submitted on time. (7-5)	Applies concepts to a few problems using an acceptable approach. (4-3)	Completes only part of the assignment with limited understanding of the concepts. (3-2)	Assignment is incomplete, inaccurate, or not submitted on time. (1)

Suggested Learning Activities may include (but are not limited to): -Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.
Suggested Innovative Delivery Methods may include (but are not limited to): -Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Group Quiz on Electric Motors and Applications	8
2.	Case Study on Electric Motor Applications in Industry	8
3.	Simulation of DC/Induction Motor Characteristics using MATLAB/Simulink/Virtual Lab	8
4.	Open Textbook Activity / Industrial Visit / expert talk on Recent Circuit Analysis Applications	8

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Video-Based Learning Reflection: Watch NPTEL/SWAYAM/MIT/ Open Course Ware lectures and submit a technical report.	8
2.	Laboratory Data Analysis using Virtual Lab: Analyse experimental readings using virtual lab platform and compare with theoretical calculations.	8
3.		
4.	(Add rows if required)	

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Microcontrollers			
Course Code	**1BEE402**	Scheme	2025
Type of course	Integrated Professional Core Course	Semester	IV
Teaching Hours/Week (L:T:P)	3:0:1	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:28:50	SEE Marks	50
Credits	**4**	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	3

Course objectives:

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

(i)Understand architecture and working of microcontrollers and embedded systems

(ii)Analyze 8051 architecture, memory, and instruction set

(iii)Develop Assembly and Embedded C programs

(iv)Implement timers, interrupts, and serial communication

(v)Interface external devices (ADC, DAC, Motors, LCD, Sensors)

(vi)Design real-time embedded applications using 8051

Module-1

8051 Architecture and Basics: Microprocessor vs Microcontroller, Embedded Systems overview, Harvard vs Von-Neumann, RISC vs CISC, 8051 Architecture: Registers, PSW, Stack Internal Memory Organization I/O Ports and Pin Configuration, External Memory Interfacing (ROM and RAM) Addressing Modes.

Number of Hours: 09

Module-2

Instruction Set and Assembly Programming: Assembly Language Programming basics, Assembler directives and data types, Instruction Set: Data Transfer, Arithmetic, Logical, Branching (Jump, Call), Stack and Subroutines, I/O Programming.

Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming.

Number of Hours:09

Module-3

Embedded C Programming and Timers (8 Hours): Data types in Embedded C, Time delay generation, I/O Programming in C, Data conversion techniques, Accessing code memory, Timer/Counter Programming: Modes of operation, Timer 0 and Timer 1, Counter applications.

Number of Hours:08

Module-4

Serial Communication and Interrupts (8 Hours): Basics of Serial Communication, RS232 and RS485 Interfacing, Serial Programming (Assembly and C), Interrupts: Types and structure, Timer and External Interrupts, Serial Interrupts Interrupt Priority,

8051 Interrupt Programming in Assembly and C: 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C.

Number of Hours:08

Module-5

Interfacing and Applications: LCD Interfacing, Keyboard Interfacing, ADC and DAC Interfacing, Sensor Interfacing and Signal Conditioning, Motor Control: Stepper Motor, DC Motor PWM Techniques, 8255 Programmable Peripheral Interface.

Number of Hours:08

List of experiments for practical components of IPCC
(1) Arithmetic operations: (a) Addition of 2, 8-bit numbers (b) Subtraction of 2, 8-bit numbers (c) Multiplication of 2, 8-bit numbers (d) Division of 2, 8-bit numbers
(2) Data transfer – Program for block data movement, sorting, exchanging, finding largest element in an array.
(3) Write an assembly language program (ALP) for Hexadecimal Down BCD Counter and Binary counter.
(4) Write an 8051 ALP to multiply two 8-bit numbers stored at 30h and 31h and Store16- bit result in 32h and 33h of internal RAM.
(5) Logical and bit manipulation
(6) Code conversion programs: BCD to ASCII, ASCII to BCD, ASCII to decimal, Decimal to ASCII, Hexa to decimal.
(7) Delay and timer programs.
Embedded C and Interfacing experiments
(8) PWM based speed and direction control of DC motor.
(9) Stepper motor speed and direction control.
(10) LCD interfacing Alphanumerical LCD panel interface.
(11) Generation of different waveforms: Sine, Square, Triangular, Ramp using DAC interface.
Textbooks: (i) The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazadi, Janice Gillspie Mazidi, Prentice Hall. (ii)The 8051 Microcontroller Architecture, Programming, and Applications, Kenneth J Ayala, West Publishing Company. (iii)8051 Microcontroller Hardware, Software, and Applications, V. Udayashankara, M.S. Mallikarjunaswamy, McGraw Hill Education.2014. **Reference books:** (i)8051 Microcontrollers Fundamental Concepts, Hardware, Software and Applications in Electronics, Salvador Pinillos Gimenez, Spinger.
Web links and Video Lectures (e-Resources): NPTEL – Embedded System Design https://nptel.ac.in/courses NPTEL – Microprocessors and Microcontrollers https://onlinecourses.nptel.ac.in Keil µVision IDE (8051 Development Tools) https://www.keil.com EdSim51 – 8051 Microcontroller Simulator https://www.edsim51.com Microchip Technology – Embedded Systems Resources https://www.microchip.com Texas Instruments – Embedded Processors and Microcontrollers https://www.ti.com Intel HEX File Format and Embedded Resources https://www.intel.com

8051 Microcontroller Tutorials
https://www.electronicwings.com/8051
Circuit Digest – 8051 Projects and Tutorials
https://circuitdigest.com/microcontroller-projects/8051-projects
All About Circuits – Embedded Systems Tutorials
https://www.allaboutcircuits.com
YouTube – NPTEL Official Channel
https://www.youtube.com/@nptelhrd
YouTube – Gate Smashers (Microprocessors & Microcontrollers)
https://www.youtube.com/@GateSmashers
YouTube – Knowledge Gate
https://www.youtube.com/@KnowledgeGate
YouTube – Embedded Systems Tutorials
https://www.youtube.com/results?search_query=8051+microcontroller+tutorial

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Interactive Lectures with Architecture Visualization.
(ii)Problem-Based Learning (PBL).
(iii)Simulation-Assisted Programming Sessions.
(iv)Hands-on Hardware Interfacing Experiments.
(v)Mini-Project and Application-Based Learning.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.
The CIE Theory component consists of IA tests for 25 marks. The CIE Practical component for continuous assessments will be for 15 marks through rubrics and for lab tests will be for 10 marks.

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE Practical component:

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The summation of all the experiments marks to be scaled down to 15 marks.
The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 10 marks. For laboratory test, the student is required to conduct one experiment.

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Performance Indicators	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
Performance Indicator–1: Conceptual Understanding (CO1, PO1)	Demonstrates excellent understanding of 8051 architecture, memory organization, instruction set, and embedded system concepts with accurate explanations.	Demonstrates good understanding with only minor conceptual errors.	Demonstrates satisfactory understanding but requires guidance.	Limited understanding of basic concepts.	Unable to explain fundamental concepts.
Performance Indicator–2: Program Development & Coding Skills (CO2, CO4, PO2, PO3)	Develops efficient Assembly and Embedded C programs with correct logic, syntax, and documentation.	Develops programs with minor logical or syntax errors.	Develops partially correct programs requiring moderate assistance.	Requires significant guidance to complete programs.	Unable to develop functional programs.
Performance Indicator–3: Problem Analysis & Debugging (CO2, CO3, PO2, PO4)	Independently analyses problems, identifies errors, and debugs efficiently.	Identifies most errors and resolves them with minimal support.	Solves problems with moderate assistance.	Has difficulty identifying program errors.	Unable to analyse or debug programs.
Performance Indicator–4: Hardware Interfacing & Implementation (CO5, PO3, PO5)	Successfully interfaces LCD, ADC, DAC, sensors, motors, or communication modules with correct implementation and testing.	Successfully completes interfacing with minor issues.	Completes interfacing with guidance and partial functionality.	Demonstrates limited ability in hardware implementation.	Unable to implement hardware interfacing.

CO–PO Mapping Used

Performance Indicator	CO Mapping	PO Mapping
PI-1: Conceptual Understanding	CO1	PO1
PI-2: Program Development & Coding Skills	CO2, CO4	PO2, PO3
PI-3: Problem Analysis & Debugging	CO2, CO3	PO2, PO4
PI-4: Hardware Interfacing & Implementation	CO5	PO3, PO5
PI-5: Documentation, Demonstration & Communication	CO5	PO9, PO10

Rubrics for CIE – Continuous assessment:

Performance Indicators	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
Performance Indicator–1: Conceptual Understanding (CO1, PO1)	Demonstrates excellent understanding of 8051 architecture, instruction set, memory organization, timers, interrupts, and embedded system concepts.	Demonstrates good understanding with very few conceptual errors.	Demonstrates satisfactory understanding but requires guidance.	Limited understanding of concepts.	Unable to explain basic concepts.
Performance Indicator–2: Programming Skills (Assembly & Embedded C) (CO2, CO4, PO2, PO3)	Develops efficient, error-free Assembly and Embedded C programs independently with proper documentation.	Develops programs with minor errors requiring minimal correction.	Develops partially correct programs with faculty guidance.	Requires considerable assistance to complete programs.	Unable to develop functional programs.
Performance Indicator–3: Problem Solving & Debugging (CO2, CO3, PO2, PO4)	Independently analyses problems, identifies errors, and debugs programs efficiently.	Solves most problems with minor support.	Solves problems with moderate guidance.	Faces difficulty in debugging and problem analysis.	Unable to analyse or debug programs.
Performance Indicator–4: Laboratory Performance & Hardware Interfacing (CO3, CO5, PO3, PO5)	Successfully performs experiments, interfaces peripherals (LCD, ADC, DAC, sensors, motors), and obtains accurate results independently.	Performs experiments with minor guidance and correct results.	Completes experiments with moderate assistance.	Performs experiments with significant support.	Unable to complete experiments successfully.
Performance Indicator–5: Documentation, Teamwork & Technical Communication (CO5, PO9, PO10)	Maintains excellent laboratory records, submits assignments on time, actively participates in discussions, and communicates technical ideas effectively.	Good documentation and participation with minor shortcomings.	Adequate documentation and communication.	Incomplete documentation and limited participation.	Poor documentation and no active participation.

CO–PO Mapping **Assessment Scale**

Performance Indicator	Course Outcome (CO)	Program Outcome (PO)	Performance Level	Score
PI-1: Conceptual Understanding	CO1	PO1	Superior	5
PI-2: Programming Skills	CO2, CO4	PO2, PO3	Good	4
PI-3: Problem Solving & Debugging	CO2, CO3	PO2, PO4	Fair	3
PI-4: Laboratory Performance & Hardware Interfacing	CO3, CO5	PO3, PO5	Need Improvement	2

Performance Indicator	Course Outcome (CO)	Program Outcome (PO)	Performance Level	Score
PI-5: Documentation, Teamwork & Technical Communication	CO5	PO9, PO10	Unacceptable	1

Rubrics for SEE / CIE Test:

Performance Indicators (CO/PO Mapping)	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
Performance Indicator-1: Conceptual Understanding (CO1, PO1)	Demonstrates complete understanding of concepts with accurate explanations and no errors.	Demonstrates good understanding with only minor errors.	Demonstrates satisfactory understanding with some conceptual gaps.	Demonstrates limited understanding with several misconceptions.	Fails to demonstrate basic understanding of concepts.
Performance Indicator-2: Problem Solving & Analytical Ability (CO2, PO2)	Solves all problems correctly using appropriate methods and logical reasoning.	Solves most problems correctly with minor calculation or reasoning errors.	Solves basic problems but struggles with complex applications.	Solves few problems correctly; significant errors in methodology.	Unable to solve problems or apply concepts.
Performance Indicator-3: Application of Engineering Knowledge (CO3, PO1, PO2)	Applies engineering principles accurately in all situations with appropriate justification.	Applies concepts correctly in most situations with minor errors.	Applies concepts in familiar situations only.	Limited ability to apply engineering knowledge.	Unable to apply engineering principles.
Performance Indicator-4: Design, Interpretation & Evaluation (CO4, PO3, PO4)	Excellent interpretation, design, and evaluation with well-supported conclusions.	Good interpretation and evaluation with minor deficiencies.	Adequate interpretation with partial justification.	Weak interpretation and incomplete conclusions.	Unable to interpret or evaluate engineering data/problems.
Performance Indicator-5: Numerical Accuracy & Calculations (CO2, PO1)	All calculations are accurate, systematic, and well presented.	Minor computational errors without affecting overall solution.	Moderate calculation errors but correct methodology.	Frequent computational errors affecting results.	Incorrect calculations throughout.
Performance Indicator-6: Presentation, Organization & Technical Writing (CO5, PO10)	Exceptionally well-organized answers with proper diagrams, units, and technical terminology.	Well-organized answers with few presentation errors.	Satisfactory presentation with minor omissions.	Poor organization and incomplete presentation.	Disorganized, unclear, and technically incorrect presentation.

Performance Level Interpretation

Score	Performance Level	Achievement (%)
5	Superior	90–100%
4	Good	75–89%
3	Fair	60–74%
2	Needs Improvement	40–59%
1	Unacceptable	Below 40%

Suggested CO–PO Mapping

Performance Indicator	Typical CO	Typical PO
Conceptual Understanding	CO1	PO1
Problem Solving & Analysis	CO2	PO2
Engineering Application	CO3	PO1, PO2
Design & Evaluation	CO4	PO3, PO4
Numerical Accuracy	CO2	PO1
Technical Presentation	CO5	PO10

Generic Rubrics for SEE / CIE Test format that can be customized for any course by replacing the CO and PO mappings.

Performance Indicators	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
Performance Indicator–1 (CO1/PO1)	Demonstrates excellent conceptual understanding and answers accurately with complete justification.	Demonstrates good understanding with minor errors.	Demonstrates satisfactory understanding with some conceptual gaps.	Demonstrates limited understanding and several errors.	Unable to demonstrate the required concepts.
Performance Indicator–2 (CO2/PO2)	Solves problems accurately using appropriate methods and logical reasoning.	Solves most problems correctly with minor mistakes.	Solves basic problems but struggles with complex applications.	Solves only a few problems correctly with major errors.	Unable to solve the given problems.
Performance Indicator–3 (CO3/PO3)	Applies engineering principles effectively to analyze and solve real-world problems.	Applies concepts correctly in most situations.	Applies concepts only in familiar situations.	Limited ability to apply engineering knowledge.	Unable to apply engineering principles.
Performance Indicator–4 (CO4/PO4)	Evaluates, interprets, and justifies solutions with excellent technical accuracy.	Provides good evaluation with minor deficiencies.	Provides adequate evaluation with partial justification.	Weak interpretation and incomplete justification.	Unable to evaluate or justify solutions.

Performance Indicators	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
Performance Indicator–5 (CO5/PO10)	Presents answers in a well-organized manner with correct diagrams, units, and technical terminology.	Well-presented answers with few presentation errors.	Satisfactory presentation with minor omissions.	Poor organization and incomplete presentation.	Disorganized and technically incorrect presentation.
Performance Indicator–n (Con /POn)	Exceeds the expected learning outcome with outstanding performance.	Meets the learning outcome with good performance.	Partially meets the learning outcome.	Meets only a small portion of the learning outcome.	Does not meet the learning outcome.

Suggested rubrics for Practical continuous assessment:

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 and PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 and PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result and Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output (3)	Student will be able to run the program but not able to analyze the output (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

Suggested Learning Activities may include (but are not limited to):
-Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):
-Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self-Learning (SL) components in Number of hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Assignment–1 and Assignment–2 based on course modules	08 Hours
2.	Seminar/Technical Presentation on recent developments related to the course	06 Hours
3.	Mini Project/Case Study/Design Problem/Simulation Activity	12 Hours
4.	Industrial Visit/Expert Talk/Field Visit/Technical Report	06 Hours
5.	Quiz, Group Discussion, Problem Solving Sessions	04 Hours
6.	Course Project Demonstration and Viva-Voce	04 Hours
	Total Hours	**40 Hours**
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Completion of MOOCs (NPTEL, SWAYAM, Coursera, edX, etc.) related to the course	10 Hours
2.	Spoken Tutorials (IIT Bombay)/Virtual Labs/Online Simulations	08 Hours
3.	Literature Survey using IEEE, Springer, ScienceDirect, Google Scholar	08 Hours
4.	Preparation of Technical Report/Presentation based on Self-learning	08 Hours
5.	Preparation of Technical Report/Presentation based on Self-learning	06Hours
	Total Hours	**40 Hours**

Continuous Internal Evaluation (CIE)

(i)Theory component

The CIE marks of 25 shall be earmarked for two tests.
The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.
Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

(ii) Laboratory component

Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed in the course syllabus.
The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined for regular class work and practical test as indicated in the Table – ICs/IPCCs 1.
(i) To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Table – ICs/IPCCs 1 Distribution of marks		
Component	**Description**	**Marks**
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
	Subtotal	**15**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
	Subtotal	**10**
	Total	**25**

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Field Theory			
Course Code	**1BEE403**	Scheme	2025
Type of Course	Professional Core Course	Semester	IV
Teaching Hours/Week (L:T:P)	3:2:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL & TW	42:28:0:50	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course objectives:

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

CO1: Apply vector algebra, vector calculus, and coordinate systems coordinate transformation techniques to solve electromagnetic field problems.

CO2: Analyse electrostatic fields, using Coulomb's law, Gauss's law, and Maxwell's first equation.

CO3: Solve electromagnetic field problems using Biot–Savart's law, Ampere's circuital law, and related field theorems.

CO4: Evaluate magnetic forces, magnetic circuits, magnetic materials, inductance, and mutual inductance, and determine the behaviour of electromagnetic systems under static magnetic field conditions.

CO5: Analyse time-varying electromagnetic fields using Maxwell's equations and evaluate electromagnetic wave propagation, power flow, and skin effect in different media.

Module-1

Vector Analysis: Introduction to scalars and vectors, dot product and cross product. Gradient of a scalar field. Divergence and Curl of a vector field.

Coordinate systems: Necessity of coordinate systems, rectangular, cylindrical, and spherical coordinate systems, relation between different coordinate systems. Expression for gradient, divergence, and curl in rectangular, cylindrical, and spherical coordinate systems. Numerical problems.

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

Number of Hours:10

Module-2

Energy and Potential: Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient. Numerical problems.

Conductor and Dielectrics: Current and current density. Continuity of current. Capacitance calculations, Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Numerical problems.

Number of Hours:08

Module-3

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

Steady magnetic fields: Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials. Numerical problems.

Number of Hours:08

Module-4

Magnetic forces: Force on a moving charge and differential current element. Force between differential current elements. Force and torque on a closed circuit. Numerical problems.

Magnetic Materials and Magnetism: Nature of magnetic materials, magnetisation and permeability. Magnetic circuit, inductance and mutual inductance. Numerical problems.

Number of Hours:08

Module-5

Time Varying Fields and Maxwell's Equations: Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Numerical problems.

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

Number of Hours:08

Textbooks:

(i)Engineering Electromagnetics, William H. Hayt et al., McGraw Hill, 8th Edition, 2014.
(ii)Principles of Electromagnetics, Matthew N. O. Sadiku, Oxford, 6th Edition, 2015.
(iii)Engineering Electromagnetics – Ganesh Rao and C.K. Narayanappa, Cengage Learning, 1st Edition, 2017.
(iv) A Textbook of Field Theory, S.P.BasavaRaj, Subhash Publishers.

Reference Books

(i)Electromagnetic Field Theory Fundamentals, Bhag Guru et al., Cambridge, 2005.
(ii)Electromagnetic Field Theory, Rohit Khurana, Vikas Publishing, 1st Edition, 2014.
(iii)Electromagnetic Field Theory and Transmission Lines, Gottapu Sasibhushana Rao, Wiley, 1st Edition, 2013.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Interactive learning.
(ii)Problem-solving based learning.
(iii)Simulation-assisted learning.
(iv)Mathematical modelling and computational learning using vector calculus, Maxwell's equations, and electromagnetic field analysis.
(v)Application-oriented learning through case studies. .

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	**Group Activity – Problem-Based Learning :** (Field visualization, vector field analysis, Maxwell equation applications, simulation using MATLAB/ ANSYS/ COMSOL/ Open EMS, case studies)	15
2.	**Self-Learning Activity** (Open Book Test/ Assignment/Video-Based Learning / MOOC/ Simulation)	10

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Activity 1: Group Activity – Electromagnetic Field Analysis (15 Marks) CO Mapping: CO2, CO3, CO4, CO5 PO Mapping: PO2, PO5,PO8, PO9	Demonstrates excellent understanding of electromagnetic field concepts, accurately analyses field problems, effectively uses simulation tools, and communicates findings confidently. (15-12)	Correctly analyses field problems with good conceptual understanding and appropriate use of simulation/analytical techniques. (11-9)	Solves most assigned problems with satisfactory understanding and acceptable teamwork. (8-6)	Demonstrates limited understanding with partial completion of assigned work. (5-3)	Minimal participation and inadequate understanding of field theory concepts. (2-1)
Activity 2: Self-Learning (10 Marks) CO Mapping: CO1, CO5 PO Mapping: PO1, PO2, PO11	Assignment/ Open Book Test completed accurately, neatly presented, and submitted on time with proper analysis. (10-9)	Good understanding with minor errors; timely submission. (8-7)	Demonstrates acceptable application of concepts to selected problems (6-5)	Partial completion with limited understanding. (4-3)	Incomplete or inaccurate submission. (2-1)

Suggested Learning Activities may include (but are not limited to):

-Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):

-Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Assignment on Vector Analysis, Electrostatics and Gauss's Law	8
2.	Problem-Based Learning (PBL): Electric and Magnetic Field Analysis	8
3.	Electromagnetic Field Simulation using	8

	MATLAB/ANSYS/COMSOL/Open EMS	
4.	Case Study/Seminar on Electromagnetic Applications (Wireless Power Transfer, MRI, Antennas, EMC, Electric Vehicles)	8
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Video-Based Learning (NPTEL/MIT OCW) on Electromagnetic Field Theory and Maxwell's Equations with Technical Report	9
2.	Simulation-Based Study: Analyse Electric/Magnetic Field Distribution and Compare Analytical & Simulation Results	9

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Transmission and Distribution			
Course Code	**1BEE404**	Scheme	2025
Type of Course	Professional Core Course	Semester	IV
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course objectives:

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

CO1: Understand the structure and operation of electrical power transmission and distribution systems, and **analyze** the advantages of HVAC, EHVAC, UHVAC, and HVDC transmission, overhead line conductors, sag characteristics, and insulator performance.

CO2: Analyse the electrical parameters of transmission lines, including resistance, inductance, and capacitance, and determine their values for single-phase and three-phase transmission lines with various conductor configurations.

CO3: Evaluate the performance of short, medium, and long transmission lines by determining their performance.

CO4: Analyse the phenomena of corona and underground cables, and evaluate their performance.

CO5: Analyse AC distribution systems and modern energy management practices.

Module-1

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

Overhead Transmission Lines: A brief introduction to types of supporting structures and line conductors- Conventional conductors; Aluminium Conductor steel reinforced (ACSR), Bundle conductor and its advantages. Introduction High temperature conductors;

Sag: Importance of sag, Sag calculation – supports at same and different levels, effect of wind and ice. Line vibration and vibration dampers. Overhead line protection against lightening; ground wires. Warning light (night lights often called Balisors) for conductor in high and medium tension lines.

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

Number of Hours:09

Module-2

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

Number of Hours:09

Module-3

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

Number of Hours:08

Module-4

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

Underground Cable: Types of cables, constructional features, insulation resistance, thermal rating, charging current, grading of cables –capacitance and inter-sheath. Dielectric loss. Comparison between ac and DC cables. Limitations of cables. Specification of power cables.

Number of Hours:08

Module-5

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

Energy Management: Introduction, need based energy management (NBEM), advantages of NBEM, Conventional distribution network, automated system for power distribution reliability; Sectionalizing switches, remote terminal units (RTUs), data acquisition system (DAS), Communication interface; power line carrier communication (PLCC), fibre optics data communication, Radio communication, public telephone communication, satellite communication.

Number of Hours:08

Textbooks:

(i)A Course in Electrical Power, Sony Gupta and Bhatnagar, Dhanpat Rai.

(ii)Principles of Power System, V.K. Mehta, Rohit Mehta, S. Chand,1stEdition2013.

(iii)Electrical Power Systems, Ashfaq Hussain, CBS Publication.

Reference Books:

(i)Power System Analysis and Design,J. Duncan Gloveratel, Cengage Learning,4thEdition2008.

(ii)Electrical power Generation, Transmission and Distribution, S.N. Singh, PHI,2ndEdition,2009.

(iii)Electrical Power,S.L. Uppal, Khanna Publication.

(iv)Electrical Power Systems,C.L.Wadhwa,NewAge,5thEdition,2009.

(v)Electric Power Distribution ,A.S.Pabla,McGraw-Hill,6thEdition,2012.

Web links and Video Lectures (e-Resources):

1. https://www.coursera.org/specializations/power-system-generation-transmission-and-protection
2. https://onlinecourses.nptel.ac.in/noc22_ee17/preview
3. https://**Electric Power Generation, Transmission and Distribution.** *Author:* S. N. Singh
4. https://www.phindia.com/Books/ShoweBooks/MTMwNw/Electrical-Power-Systems

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Case-Based Learning.

(ii)Simulation-Based Learning through software tools (such as MATLAB, PSCAD, ETAP, or Power World).

(iii)Problem-Based Learning (PBL).

(iv)Industry-Oriented Learning.

(v)Collaborative and Project-Based Learning.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Simulation based Activity: simulation based learning using MATLAB/PSCAD/ETAP, Demonstration and report and Literature writing**(8+2+5=15Marks)**	**15**
2.	Field Visit activity: visit/case study presentation/new tool or software exploration, preparation of report**(5+5=10) Marks**	**10**

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator-1 (Problem understanding / preparation / CO-PO mapping)	Demonstrates complete understanding of the activity, clear CO/PO linkage, and excellent preparation.	Shows good understanding and clear CO/PO linkage with minor gaps.	Shows partial understanding and acceptable CO/PO linkage.	Shows weak understanding and limited CO/PO linkage.	Does not demonstrate understanding or CO/PO linkage.
Performance Indicator-2 (Model setup / observation / data collection)	Performs the task accurately with correct setup, complete data, and strong relevance.	Performs the task mostly correctly with minor errors or omissions.	Performs the task with several errors or incomplete data.	Performs the task poorly with major gaps.	Task not completed or evidence is missing.
Performance Indicator-3 (Execution / analysis / technical relevance)	Executes confidently and provides strong technical analysis and interpretation.	Executes well and provides good analysis with minor shortcomings.	Executes partially and gives limited analysis.	Executes poorly with weak analysis.	No meaningful execution or analysis.
Performance Indicator-4 (Validation / documentation / report quality)	Validates results effectively and presents a clear, well-structured report.	Validates results and presents a good report with minor issues.	Provides basic validation and an average report.	Validation and documentation are weak.	No validation or report is submitted poorly.
Performance Indicator-5 (Presentation / viva / response to questions)	Presents clearly and responds accurately and confidently to questions.	Presents well and answers most questions correctly.	Presents adequately but responses are partial.	Presents poorly and responses are weak.	Unable to present or answer questions.

Suggested Learning Activities may include (but are not limited to): -Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.
Suggested Innovative Delivery Methods may include (but are not limited to): -Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours per Semester
1.	Simulation based Activity: simulation, Demonstration and report writing(15+2+8=25Hours)	**25**
2.	Field Visit activity: Pre Visit Procedure visit, preparation of report Presentation and Quiz,(3+10+5+2+2=23Hours)	**23**

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours per Semester
1.	Literature review on transmission line parameters.	
2.	Case study on HVDC or EHVAC systems.	
3.	Self-study on corona or underground cables.	
4.	Exploration of a software tool such as MATLAB, ETAP, or Power World.	

CO-PO mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	0	0	0	0	0	0	0	0	0
CO2	3	3	2	0	1	0	0	0	0	0	0
CO3	3	3	2	0	1	0	0	0	0	0	0
CO4	3	2	2	0	1	0	0	0	0	0	0
CO5	3	2	2	0	1	0	0	0	0	0	1

CO-PO mapping with justification

CO	PO mapping	Justification
CO1	PO1, PO2	This CO covers the structure of the power system, transmission levels, conductors, sag, and insulators, which are fundamental electrical engineering concepts and require analytical understanding of transmission behaviour.
CO2	PO1, PO2, PO3, PO5	The calculation of resistance, inductance, and capacitance needs strong engineering knowledge and problem analysis; the internal simulation-based activity can also support tool usage for parameter studies, so PO5 is appropriate at a low level .
CO3	PO1, PO2, PO3, PO5	Performance evaluation of short, medium, and long transmission lines requires theory, numerical analysis, and solution comparison; simulation-based work in CCA can further justify PO5.
CO4	PO1, PO2, PO3, PO5	Corona and underground cable analysis involves core electrical concepts, evaluation of performance, and possible tool-based study in internal activities, which supports PO5.
CO5	PO1, PO2, PO3, PO5, PO11	AC distribution and energy management involve engineering knowledge, system analysis, and solution development; the module on RTUs, DAS, PLCC, and communication systems supports modern tool/system awareness, and PO11 is justified because students are exposed to evolving technologies that require continuous learning .

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Electric Motors Lab			
Course Code	**1BEEL405**	Scheme	2025
Type of Course	Professional Core Course Lab	Semester	IV
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P: SL & TW	0:0:28:2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**Practical**	Exam Hours	2

Course objectives

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

(i)To conduct various tests on transformers and synchronous machines and evaluate their performance.

(ii)To perform the parallel operation on two single phase transformers.

(iii)To study and verify the performance of synchronous generator.

(iv)To calculate the voltage regulation of an alternator using different methods for comparison.

List of experiments

(1)Load test on DC shunt motor to draw performance characteristics.

(2) Load test on DC compound motor to draw performance characteristics.

(3)Speed control of DC shunt motor by armature and field control.

(4)Swinburne's Test on DC motor for predetermination of losses.

(5)Load test on three phase induction motor.

(6)No-load and Blocked rotor test on three phase induction motor to draw equivalent circuit. Determination of performance parameters at different load conditions.

(7) Determination of performance parameters at different load conditions of the three- phase induction motor from circle diagram, using no-load and blocked rotor tests.

(8)Study of speed control of a 3-phase squirrel-cage induction motor by V/f control method, using Compact Yaskawa J 1000 V/f device or any other equivalent.

(9)Direct load test on single-phase induction motor to draw output versus torque, current, power and efficiency characteristics.

(10)Load test on three-phase induction generator.

(11)Conduct suitable tests to draw the equivalent circuit of single-phase induction motor and determine performance parameters.

(12) V and Inverted V curves of synchronous motor at no load and load conditions.

Textbooks:

(i)Electric Machines, D. P. Kothari, I. J. Nagrath, McGraw Hill, 4th edition, 2011.

(ii)Theory and Performance of Electrical Machines, J. B. Gupta, Katson Books,2020.

(iii)Electrical Machinery, P.S. Bimbhra, Khanna Publishing House, 2024.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

i. Hands-on Experimental Learning.
ii. Inquiry-Based Learning.
iii. Simulation and Virtual Laboratory Learning.
iv. Data-Driven Learning through collection, plotting, and interpretation of performance curves.
v. Application-Oriented Learning.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

For both CIE and SEE, the student is required to conduct one experiment each.

Rubrics for SEE / CIE Test:

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.

A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (5 Marks) (PO1)	The student has well depth knowledge of the topics related to the course (5)	Student has good knowledge of some of the topics related to course (4)	Student is capable of narrating the answer but not capable to show in depth knowledge (3)	Student has not understood the concepts clearly (2-1)
Experimental Setup and Performance of Experiment (10 Marks) (PO2 & PO3)	Independently identifies the apparatus, makes correct connections, follows safety precautions, performs the experiment systematically, and records accurate observations without assistance. (10–9)	Performs the experiment correctly with minor guidance or minor errors in setup or observations. (8–7)	Completes the experiment with guidance and records observations with a few errors. (6–4)	Requires significant assistance in connections, operation, or recording observations, and performs the experiment incompletely. (3–1)
Result & Analysis (5 Marks) (PO4)	Accurately analyses the experimental results, plots performance characteristics correctly, compares experimental and theoretical values, and provides valid conclusions. (5)	Correctly analyses the results with minor errors in calculations or interpretation. (4)	Performs basic calculations and analyses the results with limited interpretation. (3)	Performs incomplete calculations and is unable to interpret the results correctly. (2–1)

Laboratory Record and Documentation (5 Marks) (PO10)	Record is neat, complete, well-organized, and includes objectives, circuit diagrams, observations, calculations, graphs, and conclusions. (5)	Record is complete with minor omissions or formatting issues. (4)	Record contains essential details but lacks clarity or completeness.(3)	Record is incomplete, poorly organized, or missing key sections. (2-1)
Demonstration and Viva Voce (5 Marks) (PO9)	Explains simulation procedure, observations, and answers viva questions confidently and accurately. (5)	Explains procedure and answers most questions correctly. (4)	Explains basic concepts but requires prompting during viva. (3)	Unable to explain the experiment or answer viva questions satisfactorily (2-1)

Rubrics suggested for Laboratory Test				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Procedural Write-up (10 Marks) (PO1)	Writes the aim, circuit diagram, procedure, relevant equations, and expected outcome accurately and systematically. **(10-9)**	Writes the procedure with minor omissions or errors. **(8-7)**	Writes the basic procedure but misses important details. **(6-4)**	Incomplete or incorrect procedural write-up. **(3–1)**
Experimental Setup & Conduction (10 Marks) (PO2, PO3)	Correctly sets up the experiment, follows the procedure systematically, and performs the experiment independently. **(10–9)**	Completes the setup and experiment with minor errors or minimal guidance. **(8–7)**	Performs the experiment with guidance. **(6–4)**	Unable to perform the experiment without significant assistance. **(3–1)**
Observations, Calculations & Verification (10 Marks) (PO4)	Records observations accurately, performs calculations correctly, verifies the results, and analyses the performance systematically. **(10–9)**	Performs calculations with minor errors and verifies the results satisfactorily. **(8–7)**	Performs basic calculations with partial verification. **(6–4)**	Unable to perform calculations or verify the results correctly. **(3–1)**
Results & Interpretation (10 Marks) (PO4)	Presents and interprets the results accurately, compares theoretical and simulated values, and draws appropriate conclusions. **(10–9)**	Presents results correctly with minor interpretation errors. **(8–7)**	Presents results with limited interpretation. **(6–4)**	Results are incomplete or incorrectly interpreted. **(3–1)**
Demonstration & Viva Voce (10 Marks) (PO9)	Demonstrates the experiment confidently and answers conceptual and application-based viva questions accurately. **(10–9)**	Demonstrates the experiment correctly and answers most questions satisfactorily. **(8–7)**	Demonstrates basic understanding and answers some questions with prompting. **(6–4)**	Unable to demonstrate the experiment or answer viva questions satisfactorily. **(3–1)**

Self-Learning (SL) and Term Work (TW) components in Number of Hours per semester (any one activity)		
Sl. No.	**Self-Learning & Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Compare the performance characteristics	2
2.	Identify electrical motors used on the college campus	2
3.	Conduct a motor selection exercise	2
4.	Explore industrial applications of electrical motors	2
5.	Study common faults and protection methods of electrical motors	2

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Programme: B.E. Electrical and Electronics Engineering			
Arduino, Arm and Raspberry Pi Based Projects			
Course Code	**1BEEL406A**	Scheme	2025
Type of Course	Ability Enhancement Course Lab	Semester	IV
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2

Course outcome

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

CO1: Explain the working principles, characteristics, and interfacing requirements of sensors, actuators, microcontrollers, and embedded platforms such as Arduino, ARM7, and Raspberry Pi used in engineering applications.

CO2: Develop and execute embedded programs to interface sensors, actuators, motors, and communication modules for acquiring, processing, and displaying real-time data in engineering systems.

CO3: Analyse the performance of embedded systems by interpreting sensor data, evaluating control strategies, and troubleshooting hardware and software issues in automation, IoT, and EV battery monitoring applications.

CO4: Design and implement embedded system solutions for real-world applications by integrating sensors, controllers, actuators, communication interfaces, and software to meet specified functional requirements**.**

CO5: Apply modern engineering hardware/software tools and professional practices to design, analyse, and implement engineering solutions while demonstrating ethical responsibility, effective communication, teamwork, and project management skills.

List of experiments
(1) Using a light sensor (such as GY-30 Chip: BH1750FVI or equivalent) and Arduino, find the light intensity.
(2) Using Arduino and DHT11 sensor or equivalent, determine the atmospheric temperature and humidity level.
(3) Using Arduino and motion sensor detect the movement in the given space.
(4) Design of Traffic Light Simulator for a junction having 5 incoming and outgoing lines using Arduino.
(5) Write and execute the program for Stepper Motor with ARM7 (LPC2148) processor for forward and reverse directions of rotation.
(6) Design an ARM [(Advance Risc Machine)(Risc stands for Reduced Instruction Set Computer)]-based EV battery monitoring system to assess battery health by determining battery voltage, current, temperature, and state of charge (SOC) of the battery.
(7) Control the speed of a mini–DC Motor with Raspberry Pi.
(8) Control the position of micro-servo motor used in robots.
(9) Control an IoT based LED using Raspberry Pi.
(10) Measure the distance between an object from the location of sensor such as ultrasonic sensor HCSR04 or its equivalent using Raspberry Pi.

Reference books:

(1)Embedded Systems: Architecture, Programming and Design, , Raj Kamal, McGraw Hill Education.
(2)Arduino for Beginners, Rajesh Singh, BPB Publications.
(3)Internet of Things: A Hands-On Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press (India) Pvt. Ltd.
(4)Raspberry Pi for Beginners, Shantanu Kumar, BPB Publications.

Web links and Video Lectures (e-Resources):

1. https://dronebotworkshop.com/
2. https://core-electronics.com.au/guides/
3. https://nptel.ac.in/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Hands-on Sensor and Embedded System Experiments.
(ii)Project-Based Learning (PBL).
(iii)Simulation and Hardware-in-the-Loop (HIL) Learning.
(iv)Collaborative and Problem-Based Learning.
(v)Industry-Relevant Case Studies and Mini Projects.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying 50% weightage (i.e., 50 marks each).
The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average marks for report and test shall be out of 50 marks.

Rubrics for CIE Laboratory Report (30 Marks)

Performance Indicator (5 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (5M)	Complete, neat, well-organized with aim, theory, procedure, observations and calculations without errors.	Minor omissions with good presentation.	Adequate write-up with few errors.	Incomplete write-up with several errors.	Very poor or not submitted.

PI-2: Conduction (5M)	Performs experiment independently following correct procedure and safety practices.	Performs with minimal guidance.	Performs with occasional assistance.	Performs with significant assistance.	Unable to perform experiment.
PI-3: Observation Writing (5M)	Observations recorded accurately, systematically and completely.	Minor recording errors.	Most observations recorded correctly.	Incomplete or inconsistent observations.	Observations missing or incorrect.
PI-4: Output & Analysis (5M)	Results are accurate with complete calculations, graphs and meaningful analysis.	Correct results with minor analytical errors.	Results obtained with limited analysis.	Incorrect/incomplete analysis.	Unable to obtain or analyse results.
PI-5: Team Work (5M)	Excellent collaboration, communication and responsibility throughout the experiment.	Works well with team with minor issues.	Participates adequately.	Limited participation.	Does not cooperate with team.
PI-6: Viva (5M)	Answers all questions confidently with clear conceptual understanding.	Answers most questions correctly.	Answers basic questions.	Limited understanding.	Unable to answer basic questions.

Rubrics for CIE Practical Test (20 Marks)

Performance Indicator (5 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (5M)	Complete and well-organized write-up with no errors.	Minor omissions.	Adequate documentation.	Incomplete documentation.	Poor or missing write-up.
PI-2: Conduction (5M)	Performs experiment independently with correct procedure and safety.	Performs with minimal guidance.	Performs with occasional assistance.	Requires continuous guidance.	Unable to conduct experiment.
PI-3: Output (5M)	Correct readings, calculations and expected results obtained.	Minor errors in output.	Acceptable output with few errors.	Incomplete or inaccurate output.	No meaningful output.

PI-4: Viva (5M)	Excellent conceptual understanding with confident answers.	Good understanding.	Satisfactory understanding.	Limited understanding.	No meaningful output.

Rubrics for SEE Practical Examination (50 Marks)

Performance Indicator (10 Marks Each)	5 - Excellent	4 - Very Good	3 - Good	2 - Fair	1 - Poor
PI-1: Write-up (10M)	Complete, accurate and well-presented experiment write-up with all required details.	Minor omissions but well documented.	Adequate documentation with few errors.	Incomplete documentation.	Poor or missing write-up.
PI-2: Selection of Tools & Analysis (10M)	Selects appropriate instruments/ tools correctly and performs detailed analysis with proper interpretation.	Correct tool selection with good analysis.	Appropriate tools selected with basic analysis.	Limited understanding of tool selection and analysis.	Incorrect tool selection and unable to analyse results.
PI-3: Conduction (10M)	Performs experiment independently, accurately and safely within allotted time.	Performs with minimal guidance.	Performs satisfactorily with some assistance.	Requires significant assistance.	Unable to complete experiment.
PI-4: Output (10M)	Accurate observations, calculations and expected results with proper graphs/tables wherever applicable.	Minor errors in output.	Acceptable output with limited errors.	Incomplete or inaccurate output.	Incorrect or no output.
PI-5: Viva (10M)	Demonstrates excellent conceptual knowledge, reasoning and application skills.	Good conceptual understanding.	Satisfactory understanding.	Limited conceptual knowledge.	Unable to answer fundamental questions.

- To qualify and become eligible to appear for SEE, in the CIE component, a student must secure a minimum of 40% of 50 marks, i.e., 20 marks.

- To pass the SEE component, a student must secure a minimum of 35% of 50 marks, i.e., 18 marks.
- A student is deemed to have successfully completed the course if the combined total of CIE and SEE is at least 40 out of 100 marks.

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Programme: B.E. Electrical and Electronics Engineering			
JAVA Programming			
Course Code	**1BEEL406B**	Scheme	2025
Type of Course	Ability Enhancement Course Lab	Semester	IV
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:(SL:TW)	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2

Course outcome

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

CO1: Explain the fundamentals of Java programming, including program structure, primitive data types, operators, control statements, arrays, recursion, classes, and objects.

CO2:. Apply object-oriented programming concepts including classes, objects, constructors, method overloading, and constructor overloading in Java applications.

CO3: Develop Java programs using inheritance, static and final members, and exception handling to create robust and reusable software solutions.

CO4: Design, implement, test, and debug Java programs for real-world applications involving data processing, decision-making, and object-oriented modelling.

CO5: Demonstrate professional programming practices by utilizing modern development tools, collaborating effectively, communicating technical solutions, adhering to ethical standards, managing programming tasks in teams, and engaging in self-directed learning for continuous improvement.

List of programs

(1)Write a Java program to demonstrate the basic structure of a Java program. Compile and execute the program. Display student details and perform arithmetic operations using different primitive data types.
(Concepts Explored: Introduction to Java and Primitive Data Types)

(2)Write a Java program to find all real roots of a quadratic equation $ax^2 + bx + c = 0$.
(Concepts Explored: Operators and Conditional Statements)

(3) Write a Java program to create and manipulate one-dimensional arrays to sort its elements using bubble sort technique.
(Concepts Explored: One-Dimensional Arrays)

(4)Write a Java program to create and manipulate two-dimensional arrays by Performing matrix multiplication.
(Concepts Explored: Two-Dimensional (2D) Arrays)

(5)Write a Java program for movie ticket verification of people standing in a queue, considering the following conditions:
(i)Ticket numbers from 1 to 20 represent people in the queue.
(ii)Some ticket numbers (5, 9, and 14) are identified as duplicate entries and should be skipped.
(iv)When a person with ticket number 17 is found to have an invalid ticket, the verification process should stop immediately.
Display the ticket numbers that are successfully verified.
(Concepts Explored: Jump Statements -break and continue)

(6)Write a Java program to determine whether a given number is Prime or not using selection statements.

(Concepts Explored: Control Statements)

(7)Develop a program to generate Fibonacci series using recursion.
(Concepts Explored: Recursion)

(8)Write a Java Program to create a class named Student with following data members:
(i)USN (ii)Name (iii)Branch (iv)Phone (v)Percentage
Create N student objects and display all details. (Concepts Explored: Class and Objects)

(9)Develop a Java program to demonstrate Constructor Overloading and Method Overloading using a Calculator class.
(Concepts Explored: Constructor Overloading and Method Overloading)

(10)Design a class named Bank Account class that includes:
(i)Account Number (ii)Customer Name (iii)Balance
Implement deposit, withdrawal and display of account details. (Concepts Explored: Static and Final Keywords)

(11)Design a superclass named Staff with the following data members:
ID, Name, Phone number, Salary.
Extend staff class creating the following subclasses:
(i)Teaching (domain, publications), (ii)Technical (skills), and (iii)Contract (period).
Write a JAVA program to create, read and display at least 3 staff objects, one from each of the above categories.
(Concepts Explored: Inheritance)

(12)Write a Java program to Compute a/b and handle the divide-by-zero exception using try catch.
(Concepts Explored: Exception Handling)

Textbooks:

(i) Programming with Java: A Primer, E. Balagurusamy, McGraw Hill Education (India).
(ii)Let Us Java, Yashavant P. Kanetkar, BPB Publications.
(iii)Java Programming for Core and Advanced Learners, Sagayaraj, Denis, Karthik and Gajalakshmi Universities Press (India) Pvt. Ltd.
(iv)Core Java: An Integrated Approach, R. Nageswara Rao, Dreamtech Press.

Reference Books:

(i)Herbert Schildt, Java: The Complete Reference, McGraw Hill Education.

Web links and Video Lectures (e-Resources):

1. **https://www.programiz.com/java-programming/examples**
2. **https://www.youtube.com/watch?v=xk4_1vDrzzo**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Live Coding and Demonstration-Based Learning.
(ii)Problem-Based Learning (PBL).
(iii)Hands-on Laboratory Practice and Collaborative coding, debugging, testing.
(iv)Mini-Project and Application-Oriented Learning.
(v)Online Coding Platforms, Quizzes, and Self-Learning Resources.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE Record Evaluation (30 Marks)

Performance Indicator	5 - Superior	4 - Good	3 - Fair	2 - Needs Improvement	1 - Unacceptable
PI-1: Correct Program Write-up (5M)	Complete algorithm, flow, syntax, logic and documentation are correct without errors.	Minor omissions in write-up but program logic is correct.	Program write-up is partially correct with some logical mistakes.	Incomplete write-up with major errors.	No meaningful program write-up.
PI-2: Run the Program with Zero Errors and Zero Warnings (5M)	Compiles and executes successfully without errors or warnings on first attempt.	Executes with one minor correction.	Executes after multiple corrections.	Frequent compilation / runtime errors requiring major assistance.	Unable to compile or execute the program.
PI-3: Observation Writing (5M)	Observations are complete, accurate and technically justified.	Observations are correct with minor omissions.	Basic observations recorded with limited explanation.	Incomplete or inaccurate observations.	Observations not recorded.
PI-4: Output and Analysis (5M)	Output is correct and thoroughly analysed with proper justification.	Correct output with adequate analysis.	Output is mostly correct with limited analysis.	Incorrect output or poor analysis.	No output or analysis.
PI-5: Team Work (5M)	Excellent collaboration and contribution.	Works effectively with team members.	Participates satisfactorily.	Limited participation.	Does not cooperate.
PI-6: Viva Voce (5M)	Answers all questions confidently with complete	Answers most questions correctly.	Answers basic questions with partial	Answers few questions correctly.	Unable to answer basic questions.

	conceptual understanding.		understanding.		

Rubrics for CIE Practical Test (20 Marks)

Performance Indicator	5 - Superior	4 - Good	3 - Fair	2 - Needs Improvement	1 - Unacceptable
PI-1: Program Write-up (5M)	Program design, algorithm and logic are complete and correct.	Minor omissions.	Basic logic with few mistakes.	Incomplete design.	No meaningful write-up.
PI-2: Run the Program with Zero Errors and Zero Warnings (5M)	Executes successfully without errors or warnings.	Executes after one minor correction.	Executes after several corrections.	Frequent errors requiring assistance.	Unable to execute.
PI-3: Output (5M)	Correct output for all test cases.	Correct output for most cases.	Correct output for basic cases.	Partially correct output.	No valid output.
PI-4: Viva Voce (5M)	Excellent understanding.	Good understanding.	Fair understanding.	Limited understanding.	Unable to explain.

Rubrics for SEE Practical Examination (50 Marks)

Performance Indicator	5 - Superior	4 - Good	3 - Fair	2 - Needs Improvement	1 - Unacceptable
PI-1: Program Write-up (10M)	Complete, correct and well organized.	Minor omissions.	Acceptable with some errors.	Incomplete.	No meaningful write-up.
PI-2: Software Setup (10M)	Correct IDE/project setup independently.	Minor assistance.	Moderate guidance.	Major assistance.	Unable to set up.
PI-3: Run the Program with Zero Errors and Zero Warnings (10M)	Runs successfully without errors or warnings.	Runs after one correction.	Runs after multiple corrections.	Frequent errors.	Unable to execute.
PI-4: Output (10M)	Accurate output for all test cases.	Correct for most cases.	Correct for basic cases.	Partially correct.	No valid output.
PI-5: Viva Voce (10M)	Excellent conceptual knowledge.	Good understanding.	Fair understanding.	Limited knowledge.	Unable to answer.

To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

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Programme: B.E. Electrical and Electronics Engineering			
MATLAB (Matrix Laboratory)			
Course Code	**1BEEL406C**	Scheme	2025
Type of Course	Ability Enhancement Course Lab	Semester	IV
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2

Course Outcome

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

CO1: Apply MATLAB commands, scripts, arrays, and matrix operations to solve basic mathematical and engineering problems.

CO2: Develop MATLAB programs for solving algebraic equations, performing matrix computations, and implementing numerical operations relevant to electrical and electronics engineering.

CO3: Generate, manipulate, analyse, and visualise continuous-time and discrete-time signals using MATLAB, and evaluate signal characteristics such as amplitude, energy, average power, and frequency response.

CO4: Analyse the behaviour and performance of electrical circuits, including RLC circuits, through MATLAB programming and graphical interpretation of current magnitude, phase angle, and frequency response characteristics.

CO5: Utilise Simulink tools to model, simulate, and verify electrical network theorems, circuit analysis techniques, and three-phase power systems, and evaluate active power, reactive power, and power factor.

List of experiments

(1)Write a script to perform different arithmetic operations using MATLAB software. Consider an arithmetic equation that involves all the four arithmetic operations.

(2)Basic Matrix Operations: Create matrix and array, upper and lower triangular matrix, unit and null matrix, extracting a sub-matrix, deleting rows and columns.

(3)Write a script to create an Array, and reading an Array.

(4)Write a MATLAB script for solving the algebraic equation $5x^2 - 4x + 12 = 0$.

(5)Find the transpose, inverse, square, square root, and determinant of the matrix

$$A = \begin{bmatrix} 4 & 5 & 6 \\ 1 & 3 & 7 \\ 2 & 8 & 12 \end{bmatrix}$$

using MATLAB.

(6)Write a MATLAB script for addition, subtraction, multiplication division of two matrixes.

(7)Write a MATLAB script to plot sine, cosine functions and tan plot for a given a given rms value and frequency.

(8)Write a MATLAB script for the generation of unit impulse, step, ramp, square, sawtooth, triangular signals.

(9)Write a MATLAB script to generate a discrete-time signal $x(n)$, perform amplitude scaling, time shifting, and folding operations, and compute its energy and average power.

(10)Use Simulink Editor toolbox for Mesh and nodal analysis, and Thevenin's and Norton's theorem verification.

(11)For a series RLC circuit driven by a sinusoidal AC voltage source, write a MATLAB program to calculate and plot

(a) the magnitude of the current as function of frequency for the range 100 kHz to 10 MHz.

(b) the phase angle as a function of frequency for the range 100 kHz to 10 MHz. (c) the magnitude and

phase angle of the current as a function of frequency on two subplots of a single figure.

(12)Use Simulink Editor toolbox to measure active power, reactive power and power factor of a three-phase balanced load.

Reference books:

(i) MATLAB An Introduction with Applications, Rao V. Dukkipati, New Age International (P) Ltd.
(ii) Itroduction to MATLAB, Delores M Etter, Pearson, 3rd edition.
(iii) Electronics and Circuit Analysis using MATLAB, John O. Attia, CRC Press.
(iv)MATLAB and Simulink for Engineers, Agam Kumar Tyagi, Oxford Higher Education.
(v)Introduction to Simulink with Engineering Applications, Steven T. Karris, Orchard Publications.

Web links and Video Lectures (e-Resources):

https://matlabacademy.mathworks.com/details/matlab-onramp/gettingstarted?utm_source=chatgpt.com
https://matlabacademy.mathworks.com/details/simulink-onramp/simulink?utm_source=chatgpt.com
https://www.mathworks.com/support/learn-with-matlab-tutorials.html?utm_source=chatgpt.com
https://www.mathworks.com/products/simulink/getting-started.html?utm_source=chatgpt.com

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Hands-on Computational Learning and engineering problem-solving.
(ii)Simulation-Based Learning.
(iii)Visualization-Oriented Learning through Developed plots, waveforms, frequency responses, and graphical representations of engineering systems.
(iv)Problem-Based Learning (PBL).
(v)Project and Application-Oriented Learning.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying 50% weightage (i.e., 50 marks each).
The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.
Rubrics for CIE – Continuous assessment:

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
PI-1: CO1 - MATLAB Syntax & CodingPO1: Engineering Knowledge	Code runs without error. Proper use of commands, comments, and variables	Code runs with minor warning. Basic comments	Code runs with errors corrected with help	Multiple syntax errors	Code does not run
PI-2: CO2 - Problem Formulation & AnalysisPO2: Problem Analysis	Correctly formulates equation/circuit. Analyses and verifies output logically	Correct formulation, minor analysis error	Partial formulation, needs guidance	Wrong formulation	No formulation
PI-3: CO3 - Matrix/Circuit/Signal HandlingPO3: Design	Handles matrix, array, signals, circuits correctly. Uses built-in functions effectively	Handles with 1-2 errors	Handles basic operations only	Cannot handle required operation	No attempt
PI-4: CO4 - Result Interpretation & PlottingPO4: Investigation	Plots are labeled, scaled. Interprets magnitude, phase, energy, power correctly	Plots correct, weak interpretation	Plot present, no interpretation	Incorrect plot	No plot/result
PI-5: CO5 - Simulink & Tool UsagePO5: Modern Tool Usage	Builds Simulink model independently, verifies theorem, measures P,Q,PF	Builds model with minor help	Builds partial model	Cannot build model	No Simulink work

Rubrics for SEE / CIE Test:

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output. (3)	Student will be able to run the program but not able to analyze the output. (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

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Programme: B.E. Electrical and Electronics Engineering			
Electrical Measurement Lab			
Course Code	**1BEEL406D**	Scheme	2025
Type of Course	Ability Enhancement Course Lab	Semester	IV
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0:0:28 2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2

Course outcome

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

CO1: Measure low resistance, inductance, capacitance, and frequency using appropriate DC and AC bridge circuits and evaluate the accuracy of the measurements.

CO2: Measure three-phase reactive power using the single-phase wattmeter method.

CO3: Perform displacement measurement using a Linear Variable Differential Transformer (LVDT) and analyse its characteristics.

CO4: Perform magnetic measurements using a Cathode Ray Oscilloscope (CRO) to display and analyse the hysteresis loop of magnetic materials.

CO5: Determine the ripple factor of rectifier circuits using a Cathode Ray Oscilloscope (CRO).

List of experiments

(1) Measurement of the low resistance using Kelvin Double Bridge.

(2) Measurement of inductance using Maxwell's Inductance Bridge.

(3) Measurement of inductance using Maxwell's inductance capacitance bridge.

(4) Measure the inductance of a given coil by Anderson Bridge method.

(5) Measurement of capacitance by De Sauty's bridge.

(6) Measurement of capacitance by Schering Bridge.

(7) Measurement of frequency using Wien Bridge.

(8) Measurement of 3 - Phase reactive power with single-phase wattmeter.

(9) Measurement of displacement with the help of LVDT.

(10) Display of hysteresis loop on a cathode ray oscilloscope (CRO).

(11) Determine the ripple factor using the CRO.

For the above experiment, students may refer to the Virtual Laboratory developed by IIT Kharagpur.

Virtual lab link: https://be-iitkgp.vlabs.ac.in/exp/half-wave-rectification/simulation/ halfwaverectifier_ver2.html (Virtual lab of IIT Kharagpur).

Reference books:

(i)A Course in Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney, Dhanpat Rai Publications (P) Ltd., New Delhi.

(ii) Electrical Measurements and Measuring Instruments, J. B. Gupta, S. K. Kataria & Sons.

(iii)Electrical and Electronic Measurements and Instrumentation, R. K. Rajput, S. Chand Publishing.

(iv)Electronic Instrumentation, H. S. Kalsi, McGraw Hill Education (India)

Web links and Video Lectures (e-Resources):

https://elms-iitr.vlabs.ac.in/List%20of%20experiments.html

https://www.youtube.com/playlist?list=PLrVRlSJHIkD6bj4yLx_cIRNeH5_QpOgfe

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Demonstration-Based Learning.

(ii)Experiment-Centric Hands-On Learning.

(iii)Simulation and Virtual Laboratory Learning through virtual laboratories and simulation tools (such as IIT Kharagpur Virtual Labs).

(iv)Collaborative and Inquiry-Based Learning.

(v)Project and Application-Oriented Learning.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE – Continuous assessment:

Performance Indicators	Superior (5 MARKS)	Good (4 MARKS)	Fair (3MARKS)	Needs Improvement (2 MARKS)	Unacceptable (1 MARKS)
PI-1: Pre-Laboratory Preparation (CO1, CO2 / PO1)	Objectives, theory, circuit diagram, formulae, apparatus, and procedure are complete, accurate, and well organized.	Minor omissions; preparation is substantially complete.	Basic preparation with some missing information.	Incomplete preparation requiring significant improvement.	No evidence of preparation.
PI-2: Observation and Experimental Data Recording (CO1, CO3 / PO4)	Observations are complete, accurate, neatly tabulated, with correct units and significant figures.	Minor recording errors; observations are substantially complete.	Most observations recorded with moderate errors or omissions.	Incomplete or poorly organized observations	Observations missing or incorrect.
PI-3: Calculations and Result Analysis (CO3, CO5 / PO2, PO4)	Calculations are accurate, systematic, error analysis included, and results are correctly interpreted.	Minor computational errors; interpretation is satisfactory.	Basic calculations with limited analysis.	Significant computational or analytical errors.	Calculations and analysis absent or incorrect.
PI-4: Graphs, Circuit Diagrams and Presentation (CO4 / PO5)	Circuit diagrams, graphs, and figures are neat, properly labelled, and professionally presented	Minor deficiencies in presentation or labelling.	Acceptable presentation with moderate errors.	Poorly drawn diagrams or incomplete presentation.	No diagrams/ graphs or illegible presentation.
PI-5: Discussion and	Conclusions are technically	Appropriate conclusions with minor	Basic conclusion with limited	Weak or unsupported conclusions.	No meaningful conclusion.

Conclusion (CO5 / PO4, PO10)	sound, supported by experimental results, and limitations/errors are discussed.	shortcomings.	discussion.		
PI-6: Record Maintenance and Timely Submission (CO5 / PO10)	Record is neat, complete, signed, dated, and submitted on time with all experiments updated.	Minor omissions or slight delay in submission.	Record is reasonably complete but requires improvement.	Poorly maintained or frequently delayed submission.	Record not maintained or not submitted.

Rubrics for SEE / CIE Test:

Performance Indicators	Superior (5 MARKS)	Good (4 MARKS)	Fair (3MARKS)	Needs Improvement (2 MARKS)	Unacceptable (1 MARKS)	
Measurement of Electrical Parameters (CO1 / PO1, PO4)	Accurately measures low resistance, inductance, capacitance, and frequency using appropriate bridge circuits; results are within acceptable error limits with complete calculations.	Measures all parameters correctly with minor computational or procedural errors.	Measures most parameters correctly but requires guidance; moderate errors in calculations	Performs measurements with significant procedural errors; results show large deviations.	Unable to perform measurements or obtain valid results.	
PI-2: Selection and Operation of Bridge Circuits (CO2 / PO1, PO2, PO5)	Correctly selects, configures, and operates appropriate AC/DC bridge circuits independently with proper balancing technique.	Selects and operates suitable bridge circuits with minimal assistance.	Selects appropriate bridge circuits but requires guidance during operation.	Difficulty in selecting or balancing bridge circuits; frequent errors.	Unable to select or operate the appropriate bridge circuit.	
PI-3: Measurement and Analysis of Electrical Quantities (CO3 / PO2,	Accurately measures reactive power and other electrical quantities; thoroughly analyses circuit performance and validates	Performs measurements correctly and provides satisfactory analysis	Completes measurements with partial analysis and interpretation	Measurements or analysis are incomplete or inaccurate.	Unable to measure or analyse electrical quantities.	

	results.				
PI-4: Measurement of Physical Parameters (CO4 / PO1, PO4, PO5)	Accurately measures displacement using LVDT and magnetic characteristics using CRO-based hysteresis loop experiments; interprets results correctly.	Performs experiments correctly with minor errors in measurement or interpretation.	Completes experiments with guidance; moderate errors in observations or interpretation	Significant errors in conducting experiments or recording observations.	Unable to perform experiments or interpret results.
PI-5: Data Analysis, Error Estimation and Technical Reporting (CO5 / PO3, PO4, PO10)	Performs comprehensive error analysis, accurately interprets results, and prepares a well-organized, professional laboratory report with appropriate graphs, tables, and conclusions.	Performs satisfactory analysis and submits a complete report with minor deficiencies.	Basic analysis and reporting with moderate errors or missing details.	Limited analysis; report is incomplete or poorly organized.	No meaningful analysis or report submitted.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyse the output. (3)	Student will be able to run the program but not able to analyse the output. (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

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Programme: B.E. Electrical and Electronics Engineering			
Biology for Engineers			
Course Code	**1BEE407**	Scheme	2025
Type of Course	Basic Science Course	Semester	IV
Teaching Hours/Week (L:T:P)	2:0:0	CIE Marks	50
Total Hours of Pedagogy L/T/P/(SL & TW):	28:0:0:32	SEE Marks	50
Credits	**2**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcomes

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

CO1: Explain the structure and functions of cells and the role of biomolecules in living organisms.

CO2: Describe the qualitative applications of carbohydrates, nucleic acids, proteins, lipids, and enzymes in engineering and healthcare.

CO3: Explain the structure and functioning of major human organ systems and relate them to bioengineering devices and medical technologies.

CO4: Interpret bio-inspired materials and natural mechanisms that have influenced engineering innovations.

CO5: Discuss recent trends in bioengineering, including tissue engineering, bioprinting, artificial intelligence in healthcare, bio concrete, bioremediation, and biomining.

Module-1

INTRODUCTION TO BIOLOGY:

The cell: the basic unit of life, Structure and functions of a cell. Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; (Classification (with one example each), Properties and functions of Enzymes, vitamins and hormones.

Number of Hours:05

Module-2

BIOMOLECULES AND THEIR APPLICATIONS (QUALITATIVE):

Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids in vaccine diagnosis, Proteins (Proteins as food – whey protein and meat analogues, plant-based proteins), lipids (biodiesel, cleaning agents/detergents). Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching). Number of Hours:06

Module-3

HUMAN ORGAN SYSTEMS AND BIO DESIGNS (QUALITATIVE):

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, EEG, Robotic arms for prosthetics. Eye as a Camera system (architecture, optical corrections, lens materials). Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart-related issues, reasons for blockages of blood vessels, design of stents). Lungs as a purification system (architecture, gas exchange mechanisms, spirometry, Ventilators. Kidney as a filtration system (architecture, mechanism of filtration, CKD.

Number of Hours:06

Module-4

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE):

Echolocation (ultrasonography, sonars).Bird flying (GPS and aircraft), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (friction-reducing swimsuits), Kingfisher beak (Bullet train).

Number of Hours: 06

Module-5

TRENDS IN BIOENGINEERING (QUALITATIVE):

Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and

materials. Electrical tongue and electrical nose in food science. Bioimaging and Artificial Intelligence for disease diagnosis. Self-healing Bioconcrete. Biomining via microbial surface adsorption.

Number of Hours: 05

Textbooks

(i)Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
(ii)Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
(iii)Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
(iv)Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
(v)Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
(vi)Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
(vii)Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
(viii)Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha A C Udayashankar Lambert Academic Publishing, 2019.
(ix)3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
(x)Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

Web links and Video Lectures (e-Resources):

- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
- https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
(i)Interactive Multimedia and Animation-Based Learning through animations, virtual laboratories, and digital visualizations.
(ii)Case Study–Based Learning with ECG systems, cochlear implants, dialysis machines, biophotonic sensors, and AI-enabled healthcare systems.
(iii)Problem-Based and Application-Oriented Learning considering biomedical instrumentation, biosensors, bioelectric signal acquisition, and healthcare monitoring systems.
(iv)Mini Projects and Technology Demonstrations.
(v)Research-Oriented Learning through Seminars and Literature Review.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.
To qualify and become eligible to appear for SEE, in the CIE, a student must score at least 40% of 50 marks, i.e., 20 marks.

- To pass the SEE, a student must score at least 35% of 50 marks, i.e., 18 marks.
- Notwithstanding the above, a student is considered to have passed the course, provided the combined total of CIE and SEE is at least 40 out of 100 marks.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests(IA) shall be conducted, carrying a total of 25 marks.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

It is recommended to include a maximum of two learning activities as part of the CCA to foster the holistic development of students. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Poster/Model Development on any bioengineering innovation (e.g., Artificial Kidney, Biosensors, Self-healing Concrete, Biomining, Biofuels)	15
2.	Open Book test/Assignment	10

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Poster/Model Development (15 Marks) PO2-Problem Analysis, PO3-Design development solution, PO5-Engineering tools, PO8-Ethics and Professionalism	Demonstrates comprehensive understanding of the biological concept and its engineering application with complete accuracy. (15-14)	Demonstrates good understanding with only minor inaccuracies (13-10)	Demonstrates basic understanding but misses some important concepts. (9-7)	Limited understanding with several conceptual errors. (6-3)	Fails to demonstrate understanding of the biological concept. (2-0)
Open Book test/ Assignments (10 Marks) PO1– Engineering Knowledge, PO2 – Problem Analysis, PO11 – Life-long Learning (10)	Completes the assignment/ open book test accurately neatly presented, and submitted/ written on time. (9-8)	Completes the assignment neatly presented, with only minor errors or omissions. Submitted on time. (7-5)	Applies concepts to a few problems using an acceptable approach. (4-3)	Completes only part of the assignment with limited understanding of the concepts. (3-2)	Assignment is incomplete, inaccurate, or not submitted on time (1-0)

Suggested Learning Activities may include (but are not limited to):

-Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):

-Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Group Seminar on recent advances in Bioengineering (AI in Healthcare, Tissue Engineering, RNA Vaccines, Electrical Nose/Tongue, etc.)	8
2.	Case Study Analysis on engineering solutions inspired by biology	8
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Study and prepare a report on one **bio-inspired innovation**	8
2.	Watch expert lectures/webinars	8

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering

Environmental Science Project
(Common to all Branches)

Course Code	**1BEP408**	Scheme	**2025**
Type of Course	Societal Development Course (SDC)	Semester	IV
Teaching Hours/Week (L:T:P)	(0:0:2)	CIE Marks	50
Total Hours of Pedagogy (L /T): LI(P):TW&SL	0:0:28:2	SEE Marks	50
Credits	**1**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course Objectives:

The Environmental Science Project is a practical, applied-learning course that builds students' environmental awareness and responsibility. It focuses on real issues such as climate change, pollution, biodiversity, resource use, soil erosion, and thermal comfort, using field surveys, case studies, data collection, audits, and analysis to develop feasible and sustainable solutions. Students may work individually or in groups of up to four, including interdisciplinary topics, and assessment is based on the prescribed rubrics.

Course outcome (Course Skill Set):

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

CO1 (L2 – Understand): Identify and analyse environmental problems through field interaction and technical assessment.

CO2 (L3 – Apply): Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.

CO3 (L4 – Analyze): Formulate feasible environmental problem statements and solutions considering practical constraints and sustainability aspects.

CO4 (L3 – Apply): Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.

CO5 (L4 – Analyze): Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.

CO6 (L5 – Evaluate): Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.

Restrictions and professional conduct:

Environmental Science Projects should be academic, socially responsible, technically focused, and politically neutral. Students and faculty must maintain professionalism, ethical conduct, and respect while working with communities and stakeholders, and avoid any political, ideological, commercial, or disruptive activities. Projects should also consider practical constraints such as cost, resources, safety, environmental impact, and stakeholder cooperation.

SET OF PROJECT ACTIVITIES (TW/SL = 30 HOURS)

Methods for project identification:

Students may identify the project topic using one or more of the following methods: interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.; review of issues highlighted in print and electronic media, and social networks; and, after selecting a broad topic, collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and define the problem statement and objectives clearly.

Typical Project Topics and Engineering Outcomes:

The following structured sequence of activities is to be carried out during the semester:

Typical Project Topics				
Sl. No.	**Project title**	**Measurable engineering outcome**	**Mapped POs**	**SDGs**
1	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12
2	Waste management and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow with measurable reduction in mixed waste.	PO2, PO3, PO4, PO6, PO8, PO10	SDG 11, SDG 12, SDG 13
3	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate tracking and maintenance schedule for saplings.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
4	Biogas generation and power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 11, SDG 12
5	DPR for solar power rural plant	Prepare a DPR with load assessment, panel sizing, cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 11
6	DPR for electrification of village/tribal community	Map unserved/underserved households, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 7, SDG 9, SDG 10
7	DPR for rural drainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handling capacity and flood-risk reduction.	PO1, PO2, PO3, PO4, PO6, PO10	SDG 6, SDG 9, SDG 11
8	Sustainability and environmental health projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2, PO3, PO4, PO6, PO7, PO8	SDG 3, SDG 6, SDG 11, SDG 12
9	Plastic free campaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
10	Health and nutrition awareness	Conduct baseline and post-program awareness survey and document improvement in awareness score or adoption of healthier practices.	PO2, PO6, PO7, PO8, PO9, PO10	SDG 2, SDG 3, SDG 11
11	Societal projects involving health wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9, PO10	SDG 3, SDG 11, SDG 17

12	Air quality monitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6, PO10	SDG 3, SDG 11, SDG 13
13	Plastic waste reduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic waste generation or littering.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
14	Urban greening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
15	Smart agriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or crop support.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 9
16	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12
17	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, SDG 12

Suggested Learning Resources

Particulars	Titles and Publishers
Textbooks	1. Phadke, N. D., Community Engagement and Social Innovation, Oxford University Press, New Delhi. 2. Garg, N. R., Project-Based Learning in Engineering Education, Pearson India Education Services, Noida. 3. Gupta, A. and P. Singh, Service Learning and Community Projects, McGraw-Hill Education (India), New Delhi. 4. Wilson, G., Practical Guide to Community Development Projects, Routledge, London.
Learning Resources	1. NPTEL courses on Project-Based Learning and Social Innovation. 2. SWAYAM courses on community engagement and sustainability. 3. UN Sustainable Development Goals portal. 4. MyGov India and local civic body portals for community initiatives. 5. YouTube resources on design thinking, social innovation, and community service learning. 6. NGO and government field-action case studies related to sanitation, water, health, education, and environment.
Web links and Video Lectures (e-Resources)	1. NPTEL courses on Engineering Geology. 2. NPTEL courses on Soil Mechanics and Foundation Engineering. 3. Virtual Labs – Geotechnical Engineering Virtual Lab. 4. Geological Survey of India. 5. YouTube channels on civil engineering experiments. 6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards.

Teaching Learning Process:

The suggested TLP for Community / Societal Project is as follows;

Week / Phase	Teaching–Learning Activity	Faculty Role	Student Activity	Output / Evidence
1	Course introduction, objectives, ethics, conduct, and assessment briefing	Explain course scope, rules, rubrics, and expected deliverables	Understand course requirements and form teams	Team list, course plan
2	Community problem identification and topic selection	Guide topic framing and feasibility	Identify local issues through discussion and observation	Shortlisted project topic
3	Stakeholder interaction and preliminary survey	Demonstrate survey methods and stakeholder engagement	Collect initial data from community/users	Survey notes, interview record
4	Problem statement and objective formulation	Review and refine problem statement	Prepare problem statement, scope, and objectives	Approved problem statement
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary
6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Work plan / Gantt chart
7	Feasibility analysis and solution brainstorming	Check technical feasibility and practicality	Generate possible engineering solutions	Solution alternatives sheet
8	Selection of final solution and design approach	Review final concept and design logic	Finalize concept, methods, and expected outcome	Concept note / design outline
9	Data processing / calculations / sizing / mapping	Support computations and technical review	Analyse data, perform calculations, prepare maps/charts	Technical analysis sheet
10	Prototype / model / audit / DPR / app development	Monitor progress and correct technical issues	Develop the selected output	Working model / draft DPR / map / app
11	Testing, refinement, and implementation planning	Evaluate technical correctness and improvements	Test prototype or validate proposal with users	Test results / revised output

12	Field implementation / demonstration / awareness activity	Facilitate community interaction and documentation	Conduct implementation or demonstration	Photos, attendance, implementation record
13	Documentation of outcomes, feedback, and impact	Review report structure and completeness	Compile findings, stakeholder feedback, and observations	Draft report
14	Presentation preparation and viva practice	Conduct mock presentation and feedback	Prepare slides/poster and rehearse	Presentation deck
15	Final presentation, submission, and reflection	Evaluate performance using rubrics	Present project, submit report, reflect on learning	Final report, presentation, viva

Assessment structure:

A. Continuous Internal Evaluation (CIE) – 50 marks

Students, in batches of 3–4, shall undertake at least one project (or a combination of two related activities) aiming, as far as possible, at a logical implemented or implementable outcome.

CIE will be conducted by a departmental committee (HoD/nominee, guide and one senior faculty) using the following rubrics totalling 50 marks:

CIE pass requirement:

A student shall secure a minimum of 20 marks out of 50 in CIE to become eligible to appear for SEE.

Students who fail to earn the required CIE marks may be given additional opportunities before closure of the semester; no re-doing of CIE is permitted after the end of the semester.

B. Semester End Examination (SEE) – 100 marks (scaled to 50)

Examination duration: 2 hours.

Maximum examination marks: 100 (entered as 100 in the VTU portal; the ITI-SMU module automatically scales 100 → 50 for result processing).

The SEE shall be conducted batch-wise by a committee of three faculty: project guide, one faculty from the same department and one from a different department.

SEE pass requirement and overall passing rule:

For a pass in SEE, a student shall secure minimum 35 marks out of 100.

For declaration of a pass grade, the sum of CIE marks (out of 50) and scaled SEE marks (out of 50) shall be ≥ 40; otherwise, the student is awarded grade F (Fail).

CIE Rubric — Continuous Internal Evaluation (Total 50 marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/environment	8	Problem clearly identified with strong evidence of relevance and well-defined scope.	Relevant problem with clear scope and adequate evidence.	Problem defined but justification is weak.	Problem unclear or not relevant.
Formation of problem statement; engineering	10	Precise statement; sound,	Adequate statement;	Partial statement;	Missing or infeasible.

approach, innovation & feasibility		innovative, feasible approach.	feasible with minor gaps.	marginal feasibility.	
Interaction with stakeholders; data collection, analysis & interpretation	8	Thorough engagement; comprehensive data and well-interpreted analysis.	Good engagement; adequate data and analysis.	Limited engagement; incomplete data and superficial analysis.	Little or no stakeholder contact; no data/analysis.
Project documentation; clarity, organization & problem-solving demonstrated	10	Complete, well-organized, analytical, and strong problem-solving.	Complete and clear with some analytical content.	Basic with omissions; problem-solving limited.	Missing/poorly organized; no clear problem-solving.
Communication & presentation skills	6	Confident, structured, and answers queries fully; visuals effective.	Clear and satisfactory; responds to most queries.	Acceptable but lacks clarity or confidence; weak responses.	Poor or absent; unable to respond.
Contribution & benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and realistic sustainability path.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear benefit; sustainability weak.	No evident benefit or sustainability.

Notes for CIE rubric:

Minimum CIE pass requirement: 20/50 to be eligible for SEE. [Use departmental committee (HoD/guide + senior faculty) to apply the rubric and record marks.]

SEE Rubric — Semester End Examination (Enter marks out of 100; scaled to 50 later):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/environment	16	Clearly articulated with strong evidence and context.	Clear with reasonable evidence.	Problem stated but evidence/context weak.	Poorly defined or irrelevant.
Formation of problem statement; engineering approach, innovation & feasibility	20	Precise; demonstrates engineering depth, novelty and feasibility.	Technically sound and feasible with minor limitations.	Basic; limited technical depth or feasibility concerns.	No viable engineering approach or infeasible plan.
Interaction with stakeholders; data	16	Excellent engagement; rigorous data	Good engagement	Superficial data collection and limited analysis.	Inadequate or no data; poor analysis.

collection, analysis & interpretation		collection and insightful analysis.	and acceptable analysis.		
Project documentation; clarity, technical rigor & problem-solving demonstrated	20	Comprehensive, technically rigorous, and systematic.	Complete and technically correct with minor gaps.	Lacks technical depth or has notable omissions.	Missing key elements or technically incorrect.
Communication, presentation & viva-voce responses	12	Presents expertly, defends work persuasively and answers all queries correctly.	Good presentation and satisfactory answers to most queries.	Adequate but fails to answer some technical questions.	Poor presentation and unable to defend work.
Contribution & benefit to society; impact assessment & sustainability	16	Clear, evidence-based impact assessment with scaling recommendations .	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impact or sustainability.	No coherent assessment of impact or sustainability.

SEE pass rule:

Student must secure at least 35/100 in SEE itself to be eligible for pass consideration.

Final passing is based on CIE (out of 50) + SEE (scaled to 50) >= 40. Otherwise, grade F (Fail) is awarded.

Suggested implementation notes (for BoS / exam committees):

Use numerical scores from the rubric and keep brief evaluator comments for each criterion.

For team projects: record individual contribution within the documentation and adjust individual marks using a peer-evaluation sheet or guide's assessment.

Maintain evidence (field notes, photos, questionnaires, DPRs, reports) as annexures for SEE moderation.

- Use standardized score sheet (spreadsheet) mapping rubric items to columns for easy aggregation and archival.

- Awareness Campaign on Single-Use Plastic and E-Waste Management

Suggested Learning Resources:

Text Books:

1. Benny Joseph, Environmental Studies, Tata McGraw-Hill, 2nd Edition.
2. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2005.
3. Erach Bharucha, Textbook of Environmental Studies, University Press, latest edition as available in library.
4.M. P. Poonia and S. C. Sharma, Environmental Studies, Vikas Publishing House, latest edition as available

Reference Books:

1. R. Sivakumar, Principles of Environmental Science and Engineering, Cengage Learning, 2nd Edition.
2. G. Tyler Miller Jr., Environmental Science: Working with the Earth, Thomson Brooks/Cole, 11th Edition.
3. Pratibha Singh, Anoop Singh, and Piyush Malaviya, Text Book of Environmental and Ecology, Acme Learnin 1st Edition.
4. S. M. Prakash, Environmental Studies, Elite Publishing House, Mangalore, 3rd Edition, 2018.

Web links and Video Lectures (e-Resources):

1. VTU e-Learning Centre: http://elearning.vtu.ac.in
2. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php
3. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php
4. VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec
5. VTU e-Learning Centre: http://elearning.vtu.ac.in
6. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php
7. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php
8. VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec

Assessment Structure:

Continuous Internal Evaluation (CIE) shall be conducted by the Departmental Project Review Committee consisting of a Senior Professor, the Project Guide, and one additional faculty member nominated by the Head of the Department. Semester End Evaluation (SEE) shall be conducted by university-appointed examiners. The evaluation shall be based on rubrics designed to assess the attainment of NBA-defined graduate attributes, including problem analysis, investigation, design of solutions, communication, teamwork, and professionalism**.** The weightage of marks for CIE and SEE is 50% each.

Pass Criteria: A candidate shall secure a minimum of 40% of the total marks prescribed for Project Work, subject to the required minimum in Continuous Internal Evaluation and Semester End Evaluation as per VTU regulations.

Sample Rubrics for Campus water-quality and development of a water-conservation plan.

Criterion	Weightage (%)	4 - Excellent	3 - Good	2 - Satisfactory	1 - Needs improvement
Problem definition and campus context	10	Clearly defines campus water issue, boundaries, water sources, and	Defines issue and context with minor gaps.	Basic problem stated, but scope is incomplete.	Vague or incorrect problem definition.
Water-quality data collection	15	Uses appropriate sampling points, methods, and frequency; data are well documented.	Methods are mostly appropriate with minor omissions.	Limited methods or incomplete documentation.	Weak or unclear data collection.
Water-quality parameters and analysis	20	Correctly analyses key physical, chemical, and microbiological parameters and interprets results.	Analyses most parameters correctly with minor interpretation gaps.	Some parameters analyzed, but interpretation is weak.	Minimal or incorrect analysis.
Evidence and standards comparison	15	Compares results against relevant standards/guidelines and draws valid conclusions.	Compares most results with reasonable conclusions.	Comparison is partial or uneven.	No meaningful comparison with standards.

Criterion	Weightage (%)	4 - Excellent	3 - Good	2 - Satisfactory	1 - Needs improvement
Diagnosis of issues and causes	10	Identifies likely causes of poor quality or water loss using evidence.	Identifies main causes with some support.	Causes are mentioned, but weakly supported.	Causes are speculative or absent.
Conservation plan objectives and measures	15	Plan includes clear goals, realistic measures, prioritization, and campus suitability.	Plan is relevant and mostly realistic.	Plan has some useful measures but limited prioritization.	Plan is generic or impractical.
Feasibility and implementation	10	Addresses resources, responsibilities, timeline, and implementation steps clearly.	Covers most implementation aspects.	Implementation is partial or underdeveloped.	Little or no implementation planning.
Cost, savings, and sustainability	5	Provides reasonable cost-benefit thinking and expected savings.	Includes some cost or savings discussion.	Limited financial/savings analysis.	No cost or savings consideration.
Presentation and documentation	0–10	Clear structure, tables/figures, references, and professional report quality.	Well organized with minor issues.	Acceptable but uneven formatting or writing.	Poorly organized and difficult to follow.

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Programme: B.E. Electrical and Electronics Engineering			
Electric Power Generation and Economics			
Course Code	**1BEE409**	Scheme	2025
Type of Course	Professional Core Course	Semester	IV
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course objectives

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

CO1: Explain the principles, site selection criteria, constructional features, operation, advantages, limitations, and applications of different types of power plants.

CO2: Analyse the performance characteristics, components, auxiliary systems, and operating requirements of conventional and non-conventional power generating stations, and recommend suitable generation technologies for specific conditions.

CO3: Describe the functions and operation of substations along with associated arrangements and grounding systems used in electric power networks.

CO4: Evaluate power plant performance using different plant factors for efficient power system operation.

CO5: Apply principles of power plant economics, to assess the economic performance and cost of electrical energy generation and utilisation.

Module-1

Energy Sources: Natural sources of energy.

Hydroelectric Power Plants: Hydrology, run off and stream flow, hydrograph, flow duration curve, mass curve, reservoir capacity, dam storage. hydrological cycle, merits and demerits of hydroelectric power plants, selection of site. General arrangement of hydel plant, including surge tank, elements of the plant, classification of the plants based on water flow regulation, water head and type of load the plant must supply. Examples of large hydel plants. Advantages and disadvantages of hydel plants.

Turbines: Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines governing of turbines, selection of water turbines. Underground, small hydro and pumped storage plants. Choice of size and number of units, plant layout and auxiliaries.

Number of Hours:08

Module-2

Thermal (Steam) Power Plant: General developing trends, essentials, plant layout, components, coal–its storage, preparation, handling, feeding and burning, cooling towers, fuels and fuel handling, fuel combustion and combustion equipment, fuel combustion and combustion equipment, coal burners, fluidized bed combustion, combustion control, ash handling, dust collection, draught systems, water treatment plant, high pressure boilers and steam turbines, feed water, steam power plant controls, plant auxiliaries, merits and demerits of plants. Examples of large steam power plants. Advantages and disadvantages of fossil fuel plants.

Diesel Power Plant: Introduction, merits and demerits, selection of site, elements of diesel power plant (Block diagram only)

Gas Turbine Power Plant: Introduction merits and demerits, selection of site, fuels for gas turbines, elements of gas turbine power plant.

Number of Hours:09

Module-3

Nuclear Power Plants: Introduction, economics of nuclear plants, selection of site, nuclear reaction, nuclear fission process, nuclear chain reaction, nuclear energy, nuclear fuels, nuclear plant and layout, nuclear reactor and its control, classification of reactors, power reactors in use, effects of nuclear plants, disposal of nuclear waste and effluent, shielding. Advantages and disadvantages of nuclear power plants.

Non-Conventional Power Generation: Direct energy conversion systems (Solar and Wind), Advantages and disadvantages. Number of Hours:08

Module-4

Cogeneration: Definition and scope, Cogeneration technologies, Allocation of costs, Sale of electricity and impact on cogeneration.

Substations: Classification of substations; indoor and outdoor, selection of site for substation, bus-bar arrangement schemes, single line diagrams of substations. interconnection of power stations, tie line, introduction to gas insulated substation, advantages and economics of gas insulated substation.

Introduction to substation equipment: Transformers, high voltage fuses, high voltage circuit breakers and protective relaying, high voltage disconnects switches, isolators, lightning arresters, reactors, capacitors, measuring instruments, and power line carrier communication equipment.

Number of Hours:08

Module-5

Economics: Introduction to power plant economics: Cost of electrical energy, Selection of type of generation and generation equipment, Performance and operating characteristics of power plants, Economic scheduling principle, Load duration curves: load factors, capacity factor (or plant factor), reserve factor, demand factor, and diversity factor. Effect of load on power plant design, electric tariffs, Peak load pricing Introduction, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants.

Tariffs: Objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, disadvantages, causes, methods of improving power factor, advantages of improved power factor, economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment.

Number of Hours:09

Textbooks

(i) Power Plant Engineering, P.K. Nag, Mc Graw Hill, 4 th Edition, 2014.
(ii)Generation of Electrical Energy, B.R.Gupta, S. Chand, 2015.
(iii)Electrical power Generation, Transmission and Distribution, S.N. Singh, PHI, 2nd Edition, 2009.
(iv)Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., a Text Book on Arora, S.C and Domkundawar, S., a course in Power Plant Engineering, Dhanpat Rai (2002).

Reference Books

(i)A Course in Power Systems, J.B. Gupta, Katson, 2008.
(ii) Electrical Power Distribution Systems, V. Kamaraju, McGrawHill, 1 st Edition, 2009.

Web links and Video Lectures (e-Resources):

1. **https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_me123**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(i)Multimedia-Assisted Interactive Lectures.
(ii)Case Study–Based Learning.
(iii)Industry-Oriented Problem-Solving Sessions.
(iv)Virtual Tours and Field Exposure.
(v)Seminar and Group Discussion-Based Learning.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.

- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	To explore the new technologies implemented in Power Generation through survey, present and prepare technical report.	25

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 The type of the power plants considered and quality of information including economical aspects (CO/PO Mapping)	Exhaustively considered all types of power plants (Renewable and Non renewable) and collects the latest technological implementations with examples and economical aspects (10)	Exhaustively considered all types of power plants (Renewable and Non renewable) and collects the latest technological implementations with economical aspects, but no examples (08)	considered few types of power plants (Renewable and Non renewable) and collects the technological implementations but no examples and no economical aspects (06)	Most types of power plants are considered and updated technological implementation not reported, no economical aspects (04)	Very few types of power plants are considered and general working is explained, no economical aspects (04)
Performance Indicator-2 Report preparation (CO/PO Mapping)	Report with neat diagrams and implementational aspects of all types of power plants considering economical aspects (8)	Report with neat diagrams and implementational aspects of few types of power plants considering economical aspects (6)	Report with neat diagrams and general working of few types of power plants not considering economical aspects (4)	Report with few types of power plant with no proper diagrams and aspects of economics (2)	Report with no proper diagram and information pertaining to power plants, not covering economical aspects, and no proper formatting of text (1)
Performance Indicator-3 Presentation skills and answers to the queries (CO/PO Mapping)	Excellent presentation skills covering all information in the report and answers all queries (7)	Good presentation skills covering most information in the report and answers most queries (5)	Presentation skills are good but not able to answer certain queries (4)	Not able to present clearly and not able to answer the queries (3)	Not aware of the presentation skills and not able to answer any queries. (1)

Suggested Learning Activities may include (but are not limited to):

-Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels), GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):

-Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits, ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1	Problem solving as a group activity on the topics in the course	24
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1	Online educational resource (8 week NPTEL course) / video lectures	24

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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Programme: B.E. Electrical and Electronics Engineering			
Additional Mathematics -II (Common to all Branches)			
Course Code:	**1BMATDIP410**	CIE Marks	50
Course Type	Theory	MCQ online exam Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)	3:0:0:0	Exam Hours	-
Total Hours of Pedagogy	42 hours Theory	Credits	0

Course objectives: The goal of the course **1BMATDIP410 Additional Mathematics -II (Common to all branches)** is to

CO-1: Provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for the Engineers and Scientists.

CO-2: Familiarize the importance of calculus associated with higher order differential equation with constant coefficients for all branches of the engineering.

CO-3: Apply the knowledge to find nonlinear differential equations and their respective solutions.

CO-4: Develop the knowledge of numerical methods to solve equations.

CO-5: Analyze the numerical methods by applying Ordinary Differential Equations.

CO-6: Understand and explain basic probability concepts**.**

Module-1: Ordinary Differential Equations (9 hours)

Higher order ODE's: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous and non-homogeneous equations. Inverse differential operators $e^{ax}, \sin(bx+c), \cos(bx+c)$ and polynomials. Solutions to the initial value problems. **(RBT Levels: L1, L2 and L3)**

Module-2: Non-linear differential equations (8 hours)

Non-linear differential equations: Introduction to general and singular solutions, solvable for p. Clairaut's equations, reducible to Clairaut's equations.

(RBT Levels: L1, L2 and L3)

Module-3: Numerical methods-1 (9 hours)

Introduction to the numerical methods (All formulae without proof)**:** Finite differences, Problems on Interpolation using Newton's forward and backward difference formulae, Newton's divided difference formula and Lagrange's interpolation formula.

Numerical integration: Problems on Trapezoidal, Simpson's $(1/3)^{rd}$ and Simpson's $(3/8)^{th}$ rules. **(RBT Levels: L1, L2 and L3).**

Module-4: Numerical Methods-2 (8 hours)

Solutions of algebraic and transcendental equations: Problems on Regula-Falsi and Newton-Raphson methods (only formulae).

Numerical Solution of Ordinary Differential Equations (ODE's): Numerical solution of ordinary differential equations of first order and first degree - Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order (No derivations) and problems.

(RBT Levels: L1, L2 and L3)

Module-5: Probability (8 hours)

Probability: Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability – illustrative examples. Bayes's theorem examples.

(RBT Levels: L1, L2 and L3)

Suggested Learning Resources

Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2021
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 8thEd., 2022.

Reference Books:

1. H K Das and Rajaneesh Varma, Higher Engineering Mathematics, S. Chand.
2. B. V. Ramana Higher Engineering Mathematics, McGraw Hill.
3. Mangey Ram, Mathematics in Engineering Sciences, CRC Press
4. N. P. Bali, Manish Goyal - A Textbook of Engineering Mathematics, Laxmi Publications
5. Erwin Kreyszig. Advanced Engineering Mathematics, Wiley.

Web links and e-Resources:

- NPTEL (National Programme on Technology Enhanced Learning) – Mathematics: https://nptel.ac.in/..
- SWAYAM learning modules on Engineering mathematics .
- https://www.coursera.org/ Mathematics for Engineering Specialization.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- ICT-Enabled Teaching.

Assessment Structure:

For courses offered by the Department of Mathematics, the **Continuous Internal Evaluation (CIE)** shall be conducted by the concerned course teacher. The CIE may comprise tests, assignments, quizzes, seminars, or other academic activities, as decided by the concerned teacher. The distribution of marks among these activities shall be determined by the course teacher. The total marks awarded for all CIE activities shall be **100 marks**.

The concerned teacher shall upload the CIE marks to the VTU web portal whenever notified by the University.

Online Mode of Offering for 1BMATDIP301 and 1BMATDIP401

The lecture sessions for 1BMATDIP401 shall also be made available through the **vtu.online.ac.in** platform.

1. If all the students admitted to the 3rd and 4th semesters of a college opt to pursue these courses in online mode, the entire course shall be offered online. In such cases, the Centre for Online Education, Mysuru shall conduct the **Continuous Internal Evaluation (CIE)** for **100 marks** and submit the CIE marks to the University, with a copy to the concerned college.

2. Within the **same college/department**, all admitted students shall follow a single mode of learning for these courses. A situation where a part of the students opts for the online mode and the remaining students opt for the offline mode **shall not be permitted**.
3. A college intending to offer these courses through the online mode shall submit the **list of eligible students** to the Registrar, Visvesvaraya Technological University (VTU), Belagavi, for approval. Only after obtaining the approval of the University shall the students be permitted to enrol for the online course through the vtu.online.ac.in platform**.**

Notwithstanding the above, a student is considered to have **passed the course,** provided the total of **CIE online** examination is at least 40 out of 100 marks.