BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi)

Avalahalli, Yelahanka, Bengaluru 560064

Bachelor of Engineering

Department of Electrical & Electronics Engineering

Approved in the BoS meeting held on 05.02.2026

VI Semester Scheme and Syllabus
2022 Scheme - Autonomous

Vision and Mission of the Department

Vision of the Department:

To emerge as one of the finest Electrical & Electronics Engineering Departments facilitating the development of competent professionals, contributing to the betterment of society.

Mission of the Department:

Create a motivating environment for learning Electrical Sciences through teaching, research, effective use of state of the art facilities and outreach activities.

Program Educational Objectives (PEOs)

Graduates of the program will,

PEO1	Have successful professional careers in Electrical Sciences, and Information Technology enabled areas and be able to pursue higher education.
PEO2	Demonstrate ability to work in multidisciplinary teams and engage in lifelong learning.
PEO3	Exhibit concern for environment and sustainable development.

After the successful completion of the course, the graduate will be able to,

PO1: Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4: Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6: The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8: Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9: Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10: Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11: Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12: Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

The Graduates of the Program will be able to

PSO1:	**Analyze and design electrical power systems.**
PSO2:	**Analyze and design electrical machines.**
PSO3:	**Analyze and design power electronic controllers for industrial drives.**
PSO4:	**Analyze and design analog and digital electronic systems.**

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BMS Institute of Technology and Management
(An Autonomous Institution, Affiliated to VTU Belagavi)
Avalahalli, Doddaballapur Main Road, Bengaluru, Karnataka – 560064

REVISED

Date: 18-12-2024

CONTINUOUS INTERNAL EVALUATION (CIE) AND SEMESTER END EXAMINATION (SEE) PATTERN

(Applicable to UG students admitted from the 2022 batch, effective from the Academic year 2024-25 onwards)

The UG students admitted from the 2022 batch onwards are hereby informed to note the following regarding Continuous Internal Evaluation and Semester End Examination pattern:

- The Weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Examination (SEE) is 50%.
- The Minimum passing mark for the CIE is 40% of the Maximum marks (i.e. 20 marks out of 50) and for the SEE minimum passing mark is 35% of the Maximum marks (i.e. 18 out of 50 marks).
- A student will be declared to have passed the course if they secure a minimum of 40% (i.e. 40 marks out of 100) in the combined total of the CIE and SEE.

The following tables summarize the CIE and SEE Patterns for the courses of various credits:

IPCC COURSES: 4 CREDITS OR 3 CREDITS						
Evaluation Type		**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scaled down to**	**Min. Marks to be Scored**	**Evaluation Details**
Theory Component	CIE – IA Tests	CIE – Test 1 (1.5 hr)	40	20	-	The sum of the two internal assessment tests will be **80 Marks** and the same will be scaled down to **20 Marks**.
		CIE – Test 2 (1.5 hr)	40			

	CIE – CCA (Comprehensive Continuous Assessment)	CCA	10	05	-	Any one assessment method can be used from the list appended below.
	Total CIE Theory			**25**	**10**	
Practical Component	CIE - Practical		30	15	-	Each laboratory experiment is to be evaluated for **30 Marks** using appropriate rubrics.
	CIE Practical Test		20	10	-	One test after all experiments to be conducted for **20 Marks**
	Total CIE Practical			**25**	**10**	
Total CIE Theory + Practical				**50**	**20**	
SEE			100	50	18	SEE exam is a theory exam, conducted for **100 Marks**, scored marks are scaled down to **50 Marks.**
CIE + SEE				**100**	**40**	
The laboratory component of the IPCC shall be for CIE only.						

Professional Core Courses (PCC) / Engineering Science Courses (ESC): 03 and 02 Credit						
Evaluation Type		**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scaled down to**	**Min. Marks to be Scored**	**Evaluation Details**
Theory Component	CIE – IA Tests	CIE – Test 1 (1.5 hr)	40	30	-	The sum of the two internal assessment tests will be **80 Marks** and the same will be scaled down to **30 Marks**.
		CIE – Test 2 (1.5 hr)	40			
	CIE - CCAs	CCA	20	20	-	Any Two assessment methods can be used from the list. If it is project-based, one CCA shall be given.
	Total CIE Theory			**50**	**20**	
SEE			100	50	18	SEE is a theory exam, conducted for **100 Marks**, scored marks are scaled down to **50 Marks.**
CIE + SEE				**100**	**40**	

NON-IPCC COURSES: 01 Credit Course - MCQ						
Evaluation Type		**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scaled down to**	**Min. Marks to be Scored**	**Evaluation Details**
Continuous Internal Evaluation Component	CIE – IA Tests (MCQs)	CIE – Test 1 (1 hr)	40	40	-	The question paper pattern for this course shall be an **MCQ** of **1 or 2 Marks (s).** The questions with 2 Marks can be framed based on a higher Bloom's level. The sum of the two internal assessment tests will be **80 Marks**, and the same will be scaled down to **40 Marks**.
		CIE – Test 2 (1 hr)	40			
	CIE - CCAs	CCA	10	10	-	Any One Assessment method can be used from the list provided below.
	Total CIE			**50**	**20**	
SEE (MCQ Type)				50	18	The question paper pattern for this course shall be an **MCQ** of **1 or 2 Marks (s).** The questions with 2 Marks can be framed based on higher Bloom's level. MCQ-type question papers of 50 questions with each question of a **01 Mark**, examination duration is 01 hour.
CIE + SEE				**100**	**40**	

Professional Core Course Laboratory (PCCL) /Ability Enhancement Course Laboratory (AEC) - 01 Credit					
Evaluation Type	**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scaled down to**	**Min. Marks to be Scored**	**Evaluation Details**
Continuous Internal Evaluation	CIE - Practical	30	30		Each laboratory experiment is to be evaluated for **30 Marks** using appropriate rubrics.
	CIE - Practical Test	50	20		One test after all experiments is to be conducted for **50 Marks** and to be scaled down to **20 Marks**.
	Total CIE	-	**50**	**20**	
Semester End Examination		100	50	18	SEE to be conducted for **100 Marks**.
CIE+SEE		**100**		**40**	

Learning Activities for CCAs:

A faculty member may choose the following CCAs based on the needs of the course:

1. Course project
2. Literature review
3. MOOC
4. Case studies
5. Tool exploration
6. GATE-based aptitude test
7. Open book tests
8. Industry integrated learning
9. Analysis of Industry / Technical / Business reports
10. Programming assignments with higher Bloom level
11. Group discussions
12. Industrial / Social / Rural projects

CoE 18/12/2024

Dean AA 18.12.24

Principal 18/12/24

Copy To:

1. The Vice-Principal, Deans, HoDs, and Associate HoDs
2. All faculty members and students of 2022, 2023, and 2024 batch.
3. Examination Section

BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institution Affiliated to VTU, Belagavi)

B. E. in Electrical & Electronics Engineering

Scheme of Teaching and Examinations – 2022 Scheme

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022-23 onwards)

VI Semester

Sl. No.	Course Category	Course Code	Course Title	Teaching Department (TD) & Question Paper Setting Board (PSB)	Credits Distribution				Examination				Contact Hours/week
					L	T	P	Total	CIE Marks	SEE Marks	Total Marks	SEE Duration (H)	
1	IPCC	BEE601	Power System Analysis-1	TD: EE PSB: EE	3	0	1	4	50	50	100	3	4
2	PCC	BEE602	Control Systems		4	0	0	4	50	50	100	3	4
3	PCC	BEE603	Electric Vehicle Fundamentals		3	0	0	3	50	50	100	3	3
4	PEC	BEE604X	Professional Elective Course II		3	0	0	3	50	50	100	3	3
5	OEC	BEE605X	Open Elective Course- I		3	0	0	3	50	50	100	3	3
6	PW	BEEP606	Major Project Phase- I		0	0	3	3	100	-	100	-	6
7	PCCL	BEEL607	Control Systems Laboratory		0	0	1	1	50	50	100	3	2
8	AEC	BEEL608x	Ability Enhancement Course/Skill Enhancement Course		0	0	1	1	50	50	100	2	2
9	NCMC	BNSK609	National Service Scheme (NSS)	NSS Coordinator	0	0	0	0	100	-	100	-	2
		BPEK609	Physical Education (Sports and Athletics)	PED									
		BYOK609	Yoga	Yoga Teacher									
		BNCK609	National Cadet Corps (NCC)	NCC officer									
		BMUK609	Music	Music Teacher									
10	NCMC	BIKS610	Indian Knowledge System	Any Department	0	0	0	0	100	-	100	-	2
TOTAL								**22**	**550**	**350**	**900**	**-**	

IPCC: Integrated Professional Core Course, **PCC**: Professional Core Courses, **PEC**: Professional Elective Course, **OEC**: Open Elective Course, **PCCL**: Professional Core Course laboratory, **NCMC**: Non Credit Mandatory Course, **ESC**: Engineering Science Course, **AEC**: Ability Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course II		**Open Elective Course I**		**Ability Enhancement Course**	
Course Code	**Course Name**	**Course Code**	**Course Name**	**Course Code**	**Course Name**
BEE604A	Power Electronics for Renewable Energy Systems	BEE605A	Renewable Energy Systems	BEEL608A	IoT for Electrical Systems
BEE604B	Embedded Systems	BEE605B	Energy Auditing	BEEL608B	OpAmp Laboratory
BEE604C	Electrical Estimation	BEE605C	Battery Management System	BEEL608C	Digital System Design Laboratory
BEE604D	Programmable Logic Controller	BEE605D	Introduction to Motors	BEEL608D	Computer Aided Electrical Drawing

Integrated Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical's of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme /Physical Education/Yoga/NCC/Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), Yoga (YOG), National Cadet Corps (NCC) and Music with the concerned coordinator of the course during the beginning of each semester starting from III semester to VII semester. In every semester, students should choose any one mandatory course among the available 5 courses without repeating the course again. Activities shall be carried out in each of the semesters from III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the program.
- The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the program.
- The minimum students' strength for offering open electives is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

POWER SYSTEM ANALYSIS- I (3:0:1) 4

(Effective from the academic year 2024-25)

Course Code	**BEE601**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:1	SEE Marks	50
Total Number of Contact Hours	50	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Introduce the per unit system and explain its advantages and computation.
2. Explain the concept of one-line diagram and its implementation in problems.
3. Explain analysis of three phase symmetrical faults on synchronous machine and simple power systems. Discuss selection of circuit breaker.
4. explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits.
5. explain the concept of sequence impedance and its analysis in three phase unbalanced circuits, synchronous generator, transformers and transmission lines.
6. explain the concept of sequence networks and sequence impedances of an unloaded
7. To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
8. To discuss the dynamics of synchronous machine and derive the power angle equation for a synchronous machine.
9. Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system.

Preamble:

This course is designed to provide students with a comprehensive understanding of the principles, practices, and tools used in the analysis and design of electrical power systems. As the backbone of modern society, power systems ensure the reliable delivery of electricity from generation sources to consumers, supporting critical infrastructure and everyday conveniences.

Module – 1

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

(8 Hours)

Module – 2

Symmetrical Fault Analysis: Introduction, Transient on transmission line, Short Circuit of a Synchronous Machine (On No Load), Short Circuit of a Loaded Synchronous Machine, Illustrative simple examples on power systems. Selection of Circuit Breakers.

(8 Hours)

Module – 3

Symmetrical Components: Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta transformers, Sequence Impedances of Transmission Lines, Sequence Impedances and Sequence Network of Power System, Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines, Sequence Impedances and Networks of Transformers, Construction of Sequence Networks of a Power System.

(8 Hours)

Module – 4

Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground(LG)Fault, Line-To-Line(LL)Fault, Double Line-To Ground(LLG)Fault, Open Conductor Faults. **(8 Hours)**

Module – 5

Power System Stability: Introduction, Dynamics of a Synchronous Machine, Review of Power Angle Equation, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion. **(8 Hours)**

Practical components for IPCC

Sl. No.	Experiments
1.	Write a program to draw power angle curve, reluctance power, EMF and regulation for salient and non-salient pole synchronous machines.
2.	Write a program to calculate Sag of a transmission line for i)Poles at equal height ii)Poles at unequal height
3.	Write a program to determine the efficiency, Regulation, ABCD parameters for short and long transmission line and verify AD-BC=1.
4.	Write a program to determine the efficiency, Regulation and ABCD parameters for medium transmission line for i) Π- configuration ii) T- Configuration and verify AD-BC=1.
5.	Write a program to calculate sequence components of line voltages given the unbalanced phase voltages
6.	Write a program to calculate the sequence components of line currents, given the unbalanced phase currents in a three phase i) 3-wire system ii) 4 wire system.
7.	Determination of fault currents and voltages in a single transmission line for i) Single Line to Ground Fault. ii)Line to Line Fault iii) Double Line to Ground Fault Using suitable simulating software package
8.	Determination of fault currents and voltages in a single transmission line for Three phase Fault Using suitable simulating software package.

Course Outcomes:

The students will be able to:

CO1: Model the power system components & draw per unit impedance diagram of power system.
CO2: Analyse three phase symmetrical and unsymmetrical faults on power system.
CO3: Compute unbalanced phasors in terms of sequence components and vice versa, also develop sequence networks.
CO4: Examine dynamics of synchronous machine and determine the power system stability.

Textbooks:

1. Modern Power System, D. P. Kothari, McGraw Hill, 4th Edition, 2011.
2. Elements of Power System, William D. Stevenson Jr, McGraw Hill, 4th Edition, 1982.

References:

1. Power System Analysis and Design, J. Duncan Gloveretal, Cengage, 4th Edition, 2008.
2. Power System Analysis, Hadi Sadat, McGraw Hill,1stEdition,2002.

Alternate Assessment Tools (AATs) suggested:

- Modelling single line diagram using CAED tool.
- A review test based an industrial visit to a substation.

Web links / e – resources:

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

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

CONTROL SYSTEMS (4:0:0) 4

(Effective from the academic year 2024-25)

Course Code	BEE602	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	50	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Construct mathematical models of electrical, mechanical, and electro-mechanical systems.
2. Apply signal flow graph techniques and block reduction techniques to find the transfer function.
3. Find the different time and frequency domain indices.
4. Construct root locus, bode, and Nyquist plots and comment on the stability of a given linear time-invariant system.

Preamble:

Control Systems is a key course for engineering students. It teaches the basics of control theory, which is used in many fields like electrical and mechanical engineering. In this course, students learn how to analyze, design, and build control systems.

Students will study important ideas like feedback and feed forward control, stability, and how systems respond to changes. They will learn to create models of dynamic systems using math equations and transfer functions. They will also design controllers, like PID controllers, to meet specific goals.

As for the revenue forecast, the industrial control systems market is expected to grow significantly over the next five years. The market size is projected to increase from around USD 201.77 billion in 2025 to USD 309.03 billion by 2030, with a compound annual growth rate (CAGR) of 8.9%. This growth is driven by the rising demand for automation and efficiency in various industries2.

Module – 1

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

(10 Hours)

Module – 2

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

Signal flow graphs: Construction of signal flow graphs, definition of some important terms, basic properties of signal flow graph, Mason's gain formula, signal flow graph algebra, construction of signal flow graph for control systems. Numerical. **(10 Hours)**

Module – 3

Time Domain Analysis: Introduction, Standard test signals, Unit step response of first and second order systems, time response specifications of a second order system, steady state errors and error constants.

Routh Stability criterion: Concept of stability, necessary conditions for stability, Routh-Hurwitz

Criterion, relative stability. **(10 Hours)**

Module – 4

Root locus: Introduction, Root locus concepts, construction of root loci. (Numerical only with a maximum of 4 numbers of Poles + Zeros)

Frequency domain analysis: Introduction, Co-relation between time and frequency response (2^{nd} order systems only.)

Bode plots: Basic factors G(iw)/H(jw), General procedure for constructing Bode plots, computation of gain margin and phase margin. Numerical (only with a max. of 4 numbers of Poles + Zeros) **(10 Hours)**

Module – 5

Nyquist plot: Introduction, Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion (Numerical only with a max. of 4 numbers of Poles + Zeros),

Compensators and controllers: Design with Phase-Lead Controller, Design with Phase-Lag Controller. Design with phase lead-lag controller. **Controllers:** Study the effect of P, PI, PD and PID controllers (qualitative discussion limited to block diagram level only) **(10 Hours)**

Course Outcomes:

The students will be able to:

CO1: Compare open-loop and closed-loop systems with real-time examples.
CO2: Compute the transfer function of a system based on graphical and mathematical Representation
CO3: Apply the analogous system concept for modifying system representation.
CO4: Determine the time response of an LTI system.
CO5: Apply graphical or analytical techniques to comment on system stability.

Textbooks:

1. Anand Kumar, "Control Systems", PHI Learning Private Limited, 2nd Edition, 2014
2. Nagrath & Gopal, "Control Systems Engineering", New Age International Publishers, 6th Edition, 2018

References:

1. Norman S. Nise, "Engineering control systems", Wiley India Edition, 2018
2. Richard C Dorfetal, "Modern Control Systems", Pearson 11th Edition, 2008
3. Farid Golnaraghi, Benjamin C.Kuo, "Automatic Control Systems", Wiley, 9 thEdition,2010
4. S.Salivahanan, "Control Systems Engineering", Pearson, 1^{st} Edition,2015

Alternate Assessment Tools (AATs) suggested:

1. Self-Paced online course:

i. https://matlabacademy.mathworks.com/details/simulink-fundamentals/slbe
ii. https://matlabacademy.mathworks.com/details/control-design-onramp-with simulink/controls
iii. https://matlabacademy.mathworks.com/details/reinforcement-learning-onramp/reinforcementlearning

Web links / e – resources:

- **https://onlinecourses.nptel.ac.in/noc24_de18/preview**
- **https://youtube.com/playlist?list=PLVm6hiESNN3esGDRGzWyGs8Zmej8R0Qpm&si=sDafnu7AX2cWS4tA**

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

ELECTRIC VEHICLE FUNDAMENTALS (3:0:0) 3

(Effective from the academic year 2024-25)

Course Code	**BEE603**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students:

1. To understand the basics, architecture, present & Future technologies of EV and market
2. To understand the concept of electric vehicle modelling.
3. To understand the concept of hybrid vehicles.
4. To understand various energy storage technologies.
5. To study about the motors & drives for electric vehicles.
6. To understand the failure detection, safety and high voltage system in electric vehicles

Preamble: The subject of "Electric Vehicle Fundamentals" introduces the core concepts and technologies underlying electric vehicles (EVs). This course covers the basic components of EVs, including electric motors, batteries, and power electronics, and explores how these elements work together to drive vehicle performance. Students will learn about the principles of energy storage, electric propulsion, and regenerative braking, as well as the infrastructure required for charging and maintaining EVs. By understanding these fundamentals, students will gain insight into the innovative technologies driving the shift towards cleaner, more efficient transportation solutions.

Module – 1

Introduction to Electric Vehicles: Brief history, Electric Vehicles and the Environment, Usage Patterns for Electric Road Vehicles., EV Market- Present and future trends.

Electric Vehicle Modelling: Vehicle resistance- Rolling resistance, Aerodynamic drag and Grading resistance (with numerical). EV Configuration – General EV configuration, Possible EV configurations, Traction Motor Characteristics, Tractive Effort in normal driving, Energy consumption.

(8 Hours)

Module – 2

Electric Drivetrain: Concept of Hybrid Electric Drivetrains, Architectures of Hybrid Electric Drivetrains, Series Hybrid Electric Drivetrains (Electrical Coupling)- Operation Patterns, control strategies Parallel Hybrid Electric Drivetrains (Mechanical Coupling)- Control Strategies, Fundamentals of regenerative braking and dynamic braking in electric vehicles.

(8 Hours)

Module – 3

Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Principle of operation of Lead acid Battery and Lithium Battery, Modeling of Battery. Fuel Cell- basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Electrode Potential and Current–Voltage Curve, Fuel Cell System Characteristics. Super capacitors and Flywheels.

(8 Hours)

Module – 4

Electric Vehicle Motors and Control: DC Motors - Basic principle of Operation, Brushless DC Motor, speed control - Armature voltage, Field control and Chopper control Induction Motors - Basic principle of Operation, Permanent magnet Synchronous motor (PMSM), Speed control – Stator voltage control, Constant V/f Control Switched Reluctance Motors (SRM) Drives: Basic principle of Operation, Vibration and Acoustic Noise in SRM

(8 Hours)

Module – 5

High-Voltage Electronics Fundamentals: High-Voltage DC Hazards, Safety of High-Voltage Electronics, Conductive Anodic Filaments, Floating Measurements, Y-Capacitance, HV Isolation, ESD Suppression on Isolated Devices, Isolation Detection.

Failure Detection: Overcharge/Overvoltage, Over-Temperature, Overcurrent, Battery Imbalance/Excessive Self-Discharge, Internal Short Circuit Detection, Detection of Lithium Plating, Venting Detection, Excessive Capacity Loss, Reaction Strategies.

(8 Hours)

Course Outcomes:

The students will be able to:

CO1: Analyze the history, impact of conventional vehicles on environment and safety mechanisms of electrical vehicles

CO2: Apply the engineering knowledge to model the electric vehicles, batteries and fuel cells

CO3: Analyze the drive train and control strategies of hybrid electric vehicle

CO4: Analyze the various operational characteristics and controlling mechanisms of electric vehicle motors

Textbooks:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, M. Ehsani, Y. Gao, S. Gay and Ali Emadi, CRC Press, 2005
2. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 2005

References:

1. A Systems Approach to Lithium-Ion Battery Management, Phillip Weicker, Artech House, 1st Edition ,2014.
2. Electric Vehicle Technology Explained, James Larminie, John Lowry, John Wiley & Sons Ltd, 2012
3. Hybrid, Electric and Fuel Cell Vehicles, Jack Erjavec and Jeff Arias, Cengage Learning, 2012
4. Modern Electric Vehicle Technology, C.C. Chan and K.T. Chau, Oxford University Press; 1st edition, 2001.

Alternate Assessment Tools (AATs) suggested:

- Self-Paced online course
- Poster Presentation on addressing technological, environmental, economic, and societal aspects of electric vehicles.

Web links / e – resources:

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

B.E ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS (3:0:0) 3

(Professional Elective -II) (Effective from the academic year 2024-25)

Course Code	**BEE604A**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course objectives:

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

Preamble: Power electronics plays a pivotal role in renewable energy systems by enabling efficient conversion, control, and integration of power from sources like solar, wind, and biomass. It facilitates the transformation of variable renewable energy outputs into stable, grid-compatible power, enhancing reliability and scalability. Power electronic devices, such as inverters and converters, improve energy efficiency, optimize system performance, and support grid stability, making them essential in advancing sustainable energy solutions.

Module – 1

Classification of Energy Sources – Importance of Non-conventional energy sources, Advantages and disadvantages of conventional energy sources, Impacts of renewable energy generation on the environment. **(8 Hours)**

Module – 2

Solar PV Systems: Solar PV characteristics, Grid requirement for PV, Power electronic converters used for solar PV, Control techniques, MPPT, Grid connected and Islanding mode, Grid synchronization, PLLs, battery charging in PV systems.

(8 Hours)

Module – 3

Wind Energy Conversion: Wind Turbine characteristics, Grid requirement for Wind, PMSM and DFIG for wind generators, Power electronic converters for PMSM and DFIG, Control techniques, MPPT, Grid connected and Islanding mode. **(8 Hours)**

Module – 4

Qualitative study of other renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, Fuel cells: Operating principles and characteristics. **(8 Hours)**

Module – 5

Converters for PV systems- front end buck boost, boost converters, bridge inverters for feeding the grid, Stand-alone PV systems, Grid integrated solar PV Systems – Grid Connection Issues, line

side and machine side converters for wind energy systems. **(8 Hours)**

Course outcomes:

The students will be able to

CO1: Describe the importance of renewable energy sources.

CO2: Analyze the grid requirements for Wind Energy Systems (WES) and Photovoltaic (PV) systems.

CO3: Design power electronic converters for Photovoltaic Systems (PVS), Solar Energy Systems (SES), and Wind Energy Systems (WES).

CO4: Describe biomass, fuel cells and oceanic energy sources.

Textbooks:

1. Fang Lin Luo, Hong Ye, "Advanced DC/AC Inverters: Applications in Renewable Energy" CRC Press.
2. Sudipta Chakraborty, Marcelo G. Simões, William E. Kramer, "Power Electronics for Renewable and Distributed Energy Systems" Springer 2013.

References:

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

Alternate Assessment Tools (AATs) suggested:

- Solar PV panel design based on load requirement.

Web links and Video Lectures (e-Resources):

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

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

EMBEDDED SYSTEMS (3:0:0) 3

(Professional Elective -II) (Effective from the academic year 2024-25)

Course Code	**BEE604B**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Understand technological aspects of embedded systems
2. To make use software aspects of embedded systems
3. Assess communication processes for various subsystems in an embedded system

Preamble:

An embedded system is a combination of computer hardware and software designed for a specific function. Embedded systems may also function within a larger system. The systems can be programmable or have a fixed functionality. Industrial machines, consumer electronics, agricultural and processing industry devices, automobiles, medical equipment, cameras, digital watches, household appliances, airplanes, vending machines and toys, as well as mobile devices,
are possible locations for an embedded system. The embedded systems market is valued at US\$100.12 billion.

Module – 1

Introduction to Embedded Systems

Embedded Systems, Processor embedded into a system, embedded hardware units and devices in a system, embedded software into a system, examples of embedded systems, embedded system on-chip (SOC) and use of VLSI technology in embedded systems, complex system design and processors, design process in embedded systems, formulation of a system design, design process and design examples, classification of embedded systems, skills required for an embedded system designer.

(8 Hours)

Module – 2

Advanced processor Architecture, Memory Organization and Real World Interfacing: Real world interfacing, Introduction to advanced architectures, processor and memory organization, instruction level parallelism, performance metrics, memory types, memory maps and addresses, processor selection, memory selection.

(8 Hours)

Module – 3

Devices and communication buses for device networks

IO types and examples, serial communication devices, parallel device ports, sophisticated interfacing features in device ports, wireless devices, timer and counting devices, watch-dog timer, real time clock, networked embedded system, serial bus communication protocols, parallel communication, network protocols, wireless and mobile system protocols.

(8 Hours)

Module – 4

Programming Concepts and Embedded Programming

Software Programming in an Assembly Language and in high level language 'C', C- Program

elements: header and source files, and preprocessor directives, Program Elements: Macros and Functions, data types, data structures, modifiers, statements loops and pointers, Object Oriented Programming, Embedded programming in C++.

(8 Hours)

Module – 5

Inter Process Communication And Synchronization Process, Threads and Tasks

Multiple process in an application, multiple threads in an application, tasks, task states, task and data, distinction between functions, IRS and tasks, concept of semaphores, shared data, inter-process communication, signal function, semaphore functions, message queue function, mailbox functions, pipe functions, socket functions, RPC functions.

(8 Hours)

Course Outcomes:

The students will be able to:

CO1: Comprehend the basic and technological aspects of embedded systems.
CO2: Comprehend the inter-process communication and synchronization,
CO3: Apply the software concepts of embedded systems.
CO4: Predict the devices and communication for device networks.

Textbooks:

1. Embedded System, Architecture, Programming and Design, Raj Kamal, , Tata McGraw Hill, 2nd Edition
2. Introduction to Embedded Systems - Shibu k v, Mc Graw Hill Education.

References:

1. A unified Hardware/Software Introduction, Frank Vahid, Tony Givargis, , Wiley Student Edition, 2002
2. Valvano J.W., Embedded Microcomputer Systems: Real time interfacing, Cengage Learning, 2nd edition 2009
3. Computers as Components –Wayne Wolf, Morgan Kaufmann (second edition).
4. Embedded Systems- An integrated approach - Lyla b das, Pearson education 2012.

Alternate Assessment Tools (AATs) suggested:

- Case Study: Automatic Cruise Control of Car
- Poster Presentation of advanced embedded controller architectures

Web links / e – resources:

- https://www.techtarget.com/iotagenda/definition/embedded-system
- https://nptel.ac.in/courses/108102045

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2021 Scheme

SEMESTER – VI

ELECTRICAL ESTIMATION (3:0:0) 3

(Professional Elective -II) (Effective from the academic year 2024-25)

Course Code	**BEE604C**	CIE Marks	50
Teaching Hours/Week (L: T: P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Discuss market survey, estimates, purchase enquiries, preparation of tenders, comparative statements and payment of bills and discuss Indian Electricity act and Indian Electricity rules.
2. Discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses.
3. Discuss design of lighting points and its number, total load, sub-circuits, size of conductor and types of service mains and estimation of service mains and power circuits.
4. Discuss estimation of overhead transmission and distribution system and its components.
5. Discuss main components of a substation, preparation of single line diagram of a substation and earthing of a substation.

Module – 1

PRINCIPLES OF ESTIMATION: Introduction to Estimation and Costing, Electrical Schedule, Catalogues, Market Survey and Source Selection, Recording of Estimates, Determination of Required Quantity of Material, Labour Conditions, Determination of Cost Material and Labour, Contingencies, Overhead Charges, Profit, Purchase System, Purchase

Enquiry and Selection of Appropriate Purchase Mode, Comparative Statement, Purchase Orders, Payment of Bills, Tender. **(8 Hours)**

Module – 2

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

INTERNAL WIRING: General rules for wiring, Design of Lighting Points, Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout. **(8 Hours)**

Module – 3

SERVICE MAINS: Introduction, Types, Estimation of Underground and Overhead Service Connections.

DESIGN AND ESTIMATION OF POWER CIRCUITS: Introduction, Important Considerations Regarding Motor Installation Wiring, Input Power, Input Current to Motors, Rating of Cables, Rating of Fuse, Size of Condit, Distribution Board Main Switch and Starter. **(8 Hours)**

Module – 4

ESTIMATION OF OVERHEAD TRANSMISSION AND DISTRIBUTION LINES: Cross Arms, Pole Brackets and Clamps, Guys and Stays, Conductors Configuration Spacing and Clearances, Span Lengths, Lightning Arrestors, Phase Plates, Danger Plates, Anti Climbing Devices, Bird Guards, Beads of Jumpers, Muffs, Points to be Considered at the Time of Erection of Overhead Lines, Erection of Supports, Setting of Stays, Fixing of Cross Arms, Fixing of Insulators, Conductor Erection. Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulators, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of overhead Lines, Clearances of Conductor From Ground, Spacing Between Conductors, Important Specifications. **(8 Hours)**

Module – 5

ESTIMATION OF SUBSTATIONS: Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation Main Connection Diagram, Single Line Diagram of Typical Substations, Equipment for Substation, Substation Auxiliaries Supply, Substation Earthing.

(8 Hours)

Course Outcomes:

The students will be able to:

CO1: Analyze the general principles, rules and guidelines for electrical estimation and costing of various electrical systems

CO2: Analyze various wiring materials and accessories used in different electrical wiring installations and their estimating and costing.

CO3: Analyze the general rules followed for preparing estimations and to design service connection and power wiring circuits.

CO4: Analyze the materials and accessories used for estimating and costing of different transmission line installations.

CO5: Analyze the materials and accessories used for estimating and costing of different types of electrical substations.

Textbooks:

1. Electrical Installation Estimating & Costing, J.B.Gupta,VIII Edition S.K. Katria & Sons New Delhi
2. Electrical Design Estimating and Costing, K.B.Raina S.K.Bhattacharya, New Age International
3. Electrical Estimation and Costing, Sharma Br, Tech India Publications, January 2010

References:

1. Electrical Wiring Estimating and Costing, Uppal, Khanna Publishers Delhi
2. Electrical Estimation and Costing, M A Choudhari, S M Choudhari, Nirali Prakashan Publishers, 3rd Edition, 2022
3. Electrical Wiring An Introduction, Satheesh Kumar, Ane Books Pvt Ltd., 2nd Edition.
4. I.E.Rules and Act Manuals

Alternate Assessment Tools (AATs) suggested:

- Comparative Statement on Electrical Appliances on different manufactures.
- MOOC Course.

Web links / e – resources:

- https://www.youtube.com/watch?v=FWfXQ1CthhM
- https://www.dgms.net/IErules1956.pdf
- https://www.youtube.com/watch?v=OWcDevDRaxU
- https://www.youtube.com/watch?v=X6pkJHfZUoo
- https://www.udemy.com/course/apartment-electrical-design-drawing-using-autocad-and-dialux/?couponCode=IND21PM

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) SEMESTER -VI

PROGRAMMBLE LOGIC CONTROLLERS (3:0:0)3

(Professional Elective -II)

(Effective from the academic year 2024-25)

Course Code	**BEE604D**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40 Hours	Exam Hours	3

Course objectives:

1. Gain a comprehensive understanding of how automation and control systems work in industrial and manufacturing environments.
2. Acquire the skills to program, debug, and troubleshoot PLC systems.
3. Improve employability and readiness for roles in industrial automation, manufacturing, and other sectors that rely on PLCs.

Preamble: This course is designed to provide a comprehensive understanding of PLCs, which are fundamental components in industrial automation and control systems.

Module –1

Introduction to PLCs: Overview of industrial automation and control systems, Evolution and history of PLCs, Basic components of a PLC system: CPU, input/output modules, programming device, Advantages of, PLCs over traditional relay-based control systems, Applications of PLCs in various industries, Safety considerations when working with PLCs.

(8 Hours)

Module –2

PLC Hardware and Architecture: Detailed study of PLC hardware components and their functions, Types of input/output modules: digital inputs, digital outputs, analog inputs, analog outputs, Understanding PLC memory: program memory, data memory, retentive memory, PLC rack and module configurations (**8 Hours)**

Module –3

PLC Programming Fundamentals: Introduction to PLC programming languages: ladder logic, function block diagrams, structured text, Basic instructions and programming techniques in ladder logic programming, Writing and understanding ladder logic programs for simple control tasks, Using timers, counters, and comparators in PLC programs, Introduction to advanced programming concepts: sequencers, shift registers, math functions.

(8 Hours)

Module-4

Advanced PLC Programming: Advanced programming techniques for complex control tasks, Implementing PID control loops in PLCs, Introduction to data handling and manipulation instructions, Working with data tables, arrays, and data logging in PLCs, Troubleshooting and debugging PLC programs, Case studies and real-world examples of advanced PLC applications.

(8 Hours)

Module-5

PLC Networking and Integration: Overview of PLC networking: Ethernet/IP, Modbus,

Profibus, DeviceNet, Interfacing PLCs with HMI (Human-Machine Interface) systems, Integration of PLCs with SCADA (Supervisory Control and Data Acquisition) systems, monitoring and control of PLC systems, Introduction to Industry 4.0 and the role of PLCs in smart manufacturing.

(8 Hours)

Course outcomes:

The students will be able to:

CO1: Describe the history and evolution of Programmable Logic Controllers (PLCs) and the PLC Hardware architecture.
CO2: Describe the construction and operation of commonly used field devices Associated with PLC I/O modules.
CO3: Develop programs involving basic instructions, timers, counters, comparators, sequencers, shift registers, and mathematical functions for simple control tasks using ladder logic and other PLC languages.
CO4: Apply advanced PLC programming techniques for complex control tasks involving PID control loops and data handling.
CO5: Discuss PLC networking concepts and the integration of PLCs with other Industrial automation systems.

Textbooks:

1. Programmable Logic Controllers, Frank D Petruzella, McGraw Hill, 4th Edition, 2011
2. Introduction to PLCs: A Beginner's Guide to PLCs, Elvin Perez Androver, 2012.

Reference Books:

1. Programmable Logic Controllers an Engineer's Guide, E A Parr, Newnes, 3rd Edition, 2013
2. Introduction to Programmable Logic Controllers, Gary Dunning, Cengage, 3rd Edition, 2006.
3. Introduction to Practical PLC Programming, Dilip Patel, 2018, GRIN Verlag.
4. Mastering PLC Programming, M. T White, 2023, Packt Publishing

Alternate Assessment Tools (AATs) suggested:

- Writing Ladder Logic diagrams for some industry applications

Web links / e – resources:

- https://www.g-w.com/programmable-logic-controllers-2023
- www.basicplc.com/plc-programming

B.E ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER - VI

RENEWABLE ENERGY SYSTEMS (3:0:0) 3

(Open Elective -I)

(Effective from the academic year 2024-25)

Course Code	**BEE605A**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

1. Awareness about Renewable Energy Sources and technologies.
2. Adequate inputs on a variety of issues in harnessing renewable Energy.
3. Recognize current and possible future role of renewable energy sources.

Preamble: In the face of mounting environmental challenges and the imperative to transition towards sustainable development, renewable energy systems have emerged as a cornerstone of the global energy landscape. These systems harness the inexhaustible power of natural resources such as sunlight, wind, water, and geothermal heat, offering a viable alternative to fossil fuels. By reducing greenhouse gas emissions, minimizing environmental degradation, and promoting energy security, renewable energy systems contribute significantly to the fight against climate change and the pursuit of a greener, more sustainable future.

Module – 1

Introduction: Importance of electric power generation in Indian economy, factors influencing power generation, Green energy concepts, Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

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

(8 Hours)

Module – 2

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

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

(8 Hours)

Module – 3

Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy.

Geothermal Energy: Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects. **(8 Hours)**

Module – 4

Biomass Energy: Biomass Production, Energy Plantation, Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Applications of Biomass Gasifier.

Biogas Energy: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant.

Tidal Energy: Introduction, Tidal Energy Resource, Tidal Energy Availability, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy. **(8 Hours)**

Module – 5

Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power.

Ocean Thermal Energy: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC. **(8 Hours)**

Course outcomes:

The students will be able to

CO1: Discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.

CO2: Discuss types of solar collectors, their configurations, solar cell system, its characteristics and their applications.

CO3: Explain the operation of various renewable energy systems.

CO4: Explain different emerging energy conversion technologies and storage.

Textbooks:

1. Shobh Nath Singh, "Nonconventional Energy Resources", Pearson, 1st Edition, 2015.
2. Nonconventional Energy Resources, B.H. Khan, McGraw Hill, 3rd Edition

References:

1. Godfrey Boyle, "Renewable Energy: Power for a sustainable Future", Oxford, 3rd Edition, 2012.
2. Tasneem Abbasi, S.A. Abbasi, "Renewable Energy Sources: Their Impact on global Warming and Pollution", PHI 1st Edition, 2011.
3. Nonconventional Energy Sources, G D Rai, Khanna Publisher, 2nd Edition

Alternate Assessment Tools (AATs) suggested:

- Solar System Design based on load requirement.

Web links / e – resources:

- https://onlinecourses.nptel.ac.in/noc24_ph29/preview
- https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sources-e34339149.html
- https://www.pdfdrive.com/renewable-energy-sources-and-their-applications- e33423592.html

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER - VI

ENERGY AUDITING (3:0:0) 3

(Open Elective -I)

(Effective from the academic year 2024-25)

Course Code	**BEE605B**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40 Hours	Exam Hours	3

Course objectives:

This course will enable students to:

1. Understand the current energy scenario and importance of energy conservation.
2. Understand energy economic analysis.
3. Realize energy auditing.
4. Understand the methods of improving energy efficiency in different electrical systems.
5. To explain the scope of demand side management, its concept and implementation issues and strategies

Preamble: An energy audit is completed at a residential or commercial building to determine its energy efficiency. Simply put, energy efficiency means using less energy to do the same job. The audit will provide a complete electricity consumption and energy efficiency assessment. A systematic energy audit can be broken into four phases: planning, investigating, implementing and sustaining. Proactive facilities strive to continually improve energy efficiency by repeating these phases at regular intervals.

Module – 1

Introduction: Energy Scenarios, Energy Conservation, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism, Codes, standards and Legislation.

(8 Hours)

Module – 2

Energy Economic Analysis: The time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit – numerical problems. **(8 Hours)**

Module – 3

Energy Auditing: Definition of Energy Audit, Place of Audit, Energy – Audit Methodology , Elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results.

(8 Hours)

Moule-4

Electrical System Optimization: Power Factor – correction & location of capacitors, the power triangle, motor horsepower, power flow concept, energy efficient motors, lighting basics, electrical tariff, Concept of ABT. **(8 Hours)**

Moule-5

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

Course outcome:

The student will be able to:

CO1: Analyze about energy scenario nationwide and worldwide, also outline Energy Conservation Act and its features.
CO2: Discuss load management techniques and energy efficiency.
CO3: Understand the need of energy audit and energy audit methodology.
CO4: Understand various pillars of electricity market design.
CO5: Conduct energy audit of electrical systems and buildings.
CO6: Show an understanding of demand side management and energy conservation.

Textbooks:

1. Energy Management Handbook W.C. Turner John Wiley and Sons.
2. Energy Efficient Electric Motors and Applications H.E. Jordan Plenum Pub. Corp.
3. Energy Management W. R. Murphy, G. Mckay Butterworths.

References:

1. Energy Science Principles, Technologies and Impact J. Andrews, N. Jelley Oxford University Press.
2. Market operations in power systems: Forecasting, Scheduling, and Risk Management Shahedepour M.,Yamin H., Zuyi Li. John Wiely & Sons, New York.
3. Energy Conservation Diwan, P. Pentagon Press.

Alternate Assessment Tools (AATs) suggested:

- Analysis of one-year electricity bills of the building and giving suggestions for energy Saving. Energy audit of the commercial building.

Web links / e – resources:

- https://www.energy.gov.au/
- https://www.energy.gov/scep/blueprint-2a-energy-efficiency-energy-audits-building-upgrades.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

BATTERY MANAGEMENT SYSTEM (3:0:0) 3

(Open Elective -I)

(Effective from the academic year 2024-25)

Course Code	**BEE605C**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Learn the various Battery Management System parts.
2. Understand basic information about batteries.
3. Learn to measure different battery parameters.
4. Estimate state of charge of the battery.
5. Estimate state of health of the battery.

Preamble: A battery management system has a significant impact on practicality, stability, and function detection. The voltage, temperature, and current measurements are more accurate in terms of detection. Lithium ion batteries are still in the test and small-scale application stages in terms of practicality. Even though the circuit functions of the battery management system are comparatively complete, systematic measurement and research are still lacking in the areas of group battery charging, thermal management, effective battery utilization, and state estimation.

Module – 1

Battery Management System parts: The Power Module (PM), The battery, The DC/DC converter, load, communication channel, Examples of Battery Management Systems, Comparison of BMS in a low-end and high-end shaver, Comparison of BMS in two types of cellular phones.

Basic information on batteries: Battery systems, Definitions Battery design, Battery characteristics, General operational mechanism of batteries, Basic thermodynamics, Kinetic and diffusion over potentials, Double-layer capacitance, Battery voltage. **(8 hours)**

Module – 2

Lithium-Ion Battery Fundamentals: Battery Operation, Battery Construction, Battery Chemistry, Safety Longevity, Performance, Integration.

Measurement of battery parameters: Cell Voltage Measurement, Current Measurement, Current Sensors Current Sense Measurements, Synchronization of Current and Voltage, Temperature Measurement, Measurement Uncertainty and Battery Management System Performance. (**8 hours)**

Module – 3

Battery Management System Functionality: Charging, Strategies, CC/CV Charging Method, Target Voltage Method, Constant Current Method, Thermal Management, Operational Modes. **Charge Balancing:** Balancing Strategies, Balancing Optimization, Charge Transfer Balancing, Flying Capacitor, Inductive Charge Transfer Balancing, Transformer Charge Balancing, Dissipative Balancing, Balancing Faults. (**8 hours)**

Module – 4

Battery charging algorithms: Charging algorithms for NiCd and NiMH batteries, charging modes, end-of-charge triggers and charger features, Differences between charging algorithms for NiCd and NiMH batteries, Simulation example: an alternative charging algorithm for NiCd

batteries, Charging algorithm for Li-ion batteries, The influence of charge voltage on the charging process, The influence of charge current on the charging process, Simulation example fast charging of a Li-ion battery. **(8 hours)**

Module – 5

Software Implementation: Safery-Critical Software, Design Goals, Analysis of Safety-Critical Software, Validation and Coverage, Model Implementation, Balancing, Temperature Impact on State of Charge Estimation. **(8 hours)**

Course Outcomes:

The students will be able to:

CO1: Review various Battery Management System parts.
CO2: Clarify the basic information about batteries and demonstrate Lithium-Ion Battery Fundamentals.
CO3: Measure different battery parameters and analyse battery performance to identify Battery Management System Functionality.
CO4: Understand the need of various algorithms on battery charging.
CO5: Understand the software implementation on battery.

Textbooks:

1. H. J. Bergveld, "Battery management systems: Design by modelling" University Press Facilities, Eindhoven,2001.
2. Phillip Weicker, "A Systems Approach to Lithium-Ion Battery Management", artech house, 2014

References:

1. Gregory L. Plett, "Battery Management Systems: Battery Modeling", Artech house, 2015
2. M. Barak (Ed.), T. Dickinson, U. Falk, J.L. Sudworth, H.R. Thirsk, F.L. Tye, "Electrochemical Power Sources: Primary & Secondary Batteries", IEE Energy Series 1, A. Wheaton &Co, Exeter, 1980.

Alternate Assessment Tools (AATs) suggested:

- Poster presentation on different types of Batteries.
- Simscape Battery Onramp.

Web links / e – resources:

- https://matlabacademy.mathworks.com/details/simscape-battery-onramp/orsb.
- https://files.isec.pt/DOCUMENTOS/SERVICOS/BIBLIO/Sumarios_Monografias/S ystems-approach-lithium-ion-battery_Weicker.pdf.
- https://www.scribd.com/doc/83208581/Battery-Management-Systems-Design-by-Modelling-Book.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

INTRODUCTION TO MOTORS (3:0:0) 3

(Open Elective -I)

(Effective from the academic year 2024-25)

Course Code	**BEE605D**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

1. To study the constructional features of DC Motors.
2. To study the constructional features of Three Phase and Single phase induction Motors.
3. To study the speed control of dc motor by a different methods.
4. Explain the construction and operation of Synchronous motor and special motors.

Preamble:

An electric motor is a device used to convert electricity into mechanical energy—opposite to an electric generator. They operate using principles of electromagnetism, which shows that a force is applied when an electric current is present in a magnetic field. This force creates a torque on a loop of wire present in the magnetic field, which causes the motor to spin and perform useful work. Motors are used in a wide range of applications, such as fans, power tools, appliances, electric vehicles, and hybrid cars. This course deals with construction,
operation and applications of various ac and dc motors.

Module – 1

Fundamentals: Electromagnetism, self-inductance, mutual inductance, Faraday's Law of EMI, Force produced in a conductor, vector representation of ac, concept of single phase and three phase generated emf.

(8 Hours)

Module – 2

DC Motors: Construction, Principle of operation, Classification, Back emf and significance of back emf, Torque equation, Characteristics of shunt and series motor. Speed control of the shunt motor. Application of dc motors.

(8 Hours)

Module – 3

Three Phase Induction Motors: Principle of operation, Rotating Magnetic Field, construction, classification and types; squirrel-cage, slip-ring. Slip, frequency of rotor emf (Applicable numericals on slip, speed and frequency) Torque-slip characteristics of 3-phase induction motor.

(8 Hours)

Module – 4

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

(8 Hours)

Module – 5

Synchronous Motor: Construction, Principle of operation, Methods of starting synchronous motors. Hunting and damping. Applications of synchronous motor.
Other Motors: Construction and operation of PMDC motor, Servomotor, switched reluctance motor, universal motor. Applications of each motor.

(8 Hours)

Course Outcomes:
The students will be able to:

CO1: Comprehend basic concepts of magnetic fields and ac circuits
CO2: Illustrate the construction, operation and classification of DC and AC Motors
CO3: Discuss the performance characteristics & applications of DC and ACmotors.
CO4: Discuss the control methods of speed of DC and AC motors.

Textbooks:

1. Electrical Technology Vol-II, B. L Theraja S Chand 3rd Edition
2. Electric Machines, D. P. Kothari, I. J. Nagrath, McGraw Hill, 4th edition, 2011.

References:

1. Theory of Alternating Current Machines, Alexander Langsdorf, McGraw Hill, 2nd Edition, 2001.
2. Electric Machines, Ashfaq Hussain, Dhanpat Rai & Co, 2nd Edition, 2013.
3. Electrical Machines, Dr. Nilima Zade, Shroff Publishers & Distributors Pvt. Ltd
4. Principles of Electric Machines and Power Electronics, P.C. SEN, Wiley

Alternate Assessment Tools (AATs) suggested:

- Make a list of electrical motors used in your houses and note their power rating and duration of operation in a day.
- Poster presentation of electrical motors used in large scale industrial applications

Web links / e – resources:

- https://energyeducation.ca/encyclopedia/Electric_motor
- https://nptel.ac.in/courses/108105017

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

CONTROL SYSTEM LABORATORY (0:0:1) 1

(Effective from the academic year 2024-25)

Course Code	**BEEL607**	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	50
Total Number of Contact Hours	12 Labs	Exam Hours	3

Course Objectives:

This course will enable students to:

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

Preamble:

In this Control System lab session, we will delve into the core concepts of control systems, focusing on time response, frequency response, and practical implementation. You will engage with PID controllers and compensators to enhance system performance. Additionally, experiments will involve Bode plots and root locus techniques for analyzing and designing control systems. This hands-on experience will reinforce your understanding of how to achieve precise control and stability in dynamic systems.

Sl. No.	Experiments
1.	Experiment to draw the speed torque characteristics of DC servo motor
2.	Experiment to draw synchro pair characteristics.
3.	Experiment to determine frequency response of a second order system.
4.	To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response.
5.	To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response.
6.	To simulate and draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.
7.	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. b. To evaluate the effect of additional poles and zeros on time response of second order system. b. To evaluate the effect of pole location on stability.
8.	To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.
9.	To simulate a D.C. Position control system and obtain its step response.
10.	To study the stability analysis of given control system using a) root locus, b) bode plots
	Open ended experiments
1. Study the effect of different slandered inputs on the steady state error for given i) Type-0 ii)	

Type-1 iii) Type-2.

2. Evaluate the stability of given system using RH criterion

Course Outcomes:

The students will be able to:

1. Analyze the time response of a system using MATLAB
2. Analyze the stability of a system using time domain and frequency domain techniques.
3. Design compensators to enhance the stability and performance of control systems.
4. Plot toque- speed characteristics of DC and AC servomotors.
5. Analyze the effect of P, PI, PD and PID controllers on a control system.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

IoT FOR ELECTRICAL SYSTEMS LABORATORY(0:0:1) 1

(Ability Enhancement Course)

(Effective from the academic year 2024-25)

Course Code	**BEEL608A**	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	50
Total Number of Contact Hours	12 Labs	Exam Hours	3

Course Objectives:

This course enables students to:

1. To impart necessary and practical knowledge of components of Internet of Things
2. To develop skills required to build real-life IoT based projects using ESP8266/ESP32.

Preamble:

This course will describe the Internet of Things (IoT), the technology used to build various kind of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them.

Sl. No.	Experiments
1.	Write a program to control ON/OFF of LED/Buzzer using Push button.
2.	Write a program to interface with IR and LDR Digital sensors
3.	Write a program to interface DHT11 sensor/LCD and print temperature and humidity readings.
4.	Write programs to interface with potentiometer and ultrasonic Sensor
5.	Write programs to interface with Pyrosensor and Smoke sensor
6.	Write a program to upload/retrieve temperature and humidity data to thing speak cloud.
7.	Write a program to publish temperature data to MQTT broker and also to subscribe to MQTT broker for temperature data and print it.
8.	Write a program to create TCP server on and respond with humidity data to TCP client when requested.
9.	Write a program to interfacing with DC Motor for direction and speed control.
10.	i. Write a program to interfacing with Stepper Motor for direction and speed control. ii. Write a program to interfacing with Servo Motor for position control.

Open ended experiments

1. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.
2. Write a program to control water level in a tank.
3. Write a program to control traffic signals at four different junctions.

Course Outcomes:

The students will be able to:

CO1: Design and Develop C/C+ programs for ESP8266/32 based systems. CO2: Design and Develop key board/display systems.

CO3: Design and Develop analog/digital sensor data acquisition systems. CO4: Design and Develop Motor control systems.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme SEMESTER – VI

OP-AMP LABORATORY (0:0:1) 1

(Ability Enhancement Course) (Effective from the academic year 2024 -2025)

Course Code	**BEEL608B**	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	50
Total Number of Lecture Hours	12 Labs	Exam Hours	2

Laboratory Prerequisites:

1. Knowledge of pin details and parameters of linear ICs.
2. Knowledge of general linear applications of op-amp.
3. Knowledge of op-amp in switching circuits.

Laboratory Objectives:

1. To design and conduct experiments using op-amp
2. To design and conduct experiments using Linear IC's.

List of Experiments:

1. Voltage follower, Inverting and non-inverting amplifier
2. Inverting and non-inverting summing and difference amplifier
3. Precision half wave and full wave rectifier
4. Phase shift oscillator
5. Schmitt trigger
6. Linear ICs as voltage regulator
7. First order active low pass, high pass and band pass filter.
8. Digital to Analog converter
9. Analog to Digital converter
10. 555 timer as Astable and Monostable multivibrator

Open Ended Experiments:

1. Function generator

Course Outcomes:

This course will enable students to

CO1: Design and conduct general linear circuits using op-amp
CO2: Design and conduct Schmitt trigger circuits using op-amp
CO3: Design and conduct oscillators and filters using op-amp
CO4:Design and conduct voltage regulators and A/D & D/A converters using op-amp
CO5: Design and conduct multivibrators using IC 555

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme SEMESTER - VI

DIGITAL SYSTEM DESIGN LABORATORY (0:0:1)

(Ability Enhancement Course)

(Effective from the academic year 2024 -2025)

Course Code	**BEEL608C**	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	50
Total Number of Lecture Hours	12 Labs	Exam Hours	2

Laboratory Prerequisites:

1. Knowledge about Digital Electronics
2. Knowledge about simulation tools like SPICE and ModelSim etc.,

Laboratory Objectives:

This course will enable students to design, realization and verification of

1. Demorgan's Theorem, SOP, POS forms
2. Full/Parallel Adders, Subtractors and Magnitude Comparator
3. Multiplexers using logic gates
4. Demultiplexers and Decoders
5. Flip-Flops, Shift registers and Counters.

Experiments:

1. Simplification, realisation of Boolean expressions using logic gates/universal gates
2. Realisation of half/full adder and half/full Subtractor using logic gates
   - **(a)** Realisation of parallel adder/Subtractor using 7483 IC
   - **(b)** BCD to excess-3 code conversion and vice versa
3. Realisation of binary to gray code conversion and vice versa
4. MUX/DEMUX – use of 74153, 74139 for arithmetic circuits and code converter
5. Realisation of one/two-bit comparator and Design of magnitude comparator using IC 7485.
6. Use of **(a)** Decoder IC to drive LED display and **(b)** Priority encoder
7. Truth table verification of flip-flops of **(a)** JK master slave (**b)** T type and **(c)** D type
8. Realization of 3-bit counters as a sequential circuit and MOD-N counter design (IC 7476,
   - **(a)** IC7490, IC 74192 and IC 74193).Shift left, shift right, SIPO, SISO, PISO and PIPO operations using 7495.

Open Ended Experiments

1. Wiring and testing Ring counter/Johnson Counter
2. Wiring and testing of Sequence Generator.
3. Simulate Full Adder using any simulation tool
4. Simulate Mod-8 Synchronous UP/DOWN Counter using Simulation tool,

Course Outcomes:

This course will enable students to design, realization and verification of

CO1: Design the truth table of various expressions and combinational circuits using logic Gates.

CO2: Design, test and evaluate various combinational circuits such as adders, subtractors, comparators, multiplexers and demultiplexers.

CO3: Analyze and design flips-flops, counters and shift registers.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme SEMESTER - VI

COMPUTER AIDED ELECTRICAL DRAWING (0:0:1) 1

(Effective from the academic year 2024 -2025)

Course Code	**BEEL608D**	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	50
Total Number of Lecture Hours	12 labs	Exam Hours	3

Course objectives:

This course enables students to:

1. To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
2. To discuss the substation equipment, their location in a substation and development of a layout for Substation.
3. To discuss different sectional views of transformers, DC machine and its parts.

Preamble:

This course will be used to perform various practical exercises using CAD tool. Also it will enable the students to become competent for working in the fast growing information technology environment by enhancing their computer aided drawing, designing and skills in the field of electrical engineering.

Sl. No.	Experiments
1.	Draw the single line diagram of electrical substation.
2.	Design and Draw the single layer simplex DC progressive Lap and wave winding diagram.
3.	Design and Draw the single layer simplex DC Retrogressive Lap and wave winding diagram.
4.	Design and Draw the double layer simplex DC progressive Lap and Wave winding diagram.
5.	Design and Draw the double layer simplex DC Retrogressive Lap and Wave winding diagram.
6.	Design and Draw the double layer AC Integral Slot Lap and Wave winding diagram.
7.	Design and Draw the double layer AC fractional Slot Lap and Wave winding diagram.
8.	Design and Draw the sectional plan or elevation of single phase or three phase core type transformer.
9.	Design and Draw the sectional plan and elevation of single phase shell type transformer.
10.	Design and Draw the sectional plan and elevation of DC machine.

Course outcomes:

The students will be able to:

CO1: Develop a Single Line Diagram of Generating Stations and substation using the standard symbols.

CO2: Develop armature-winding diagram for DC and AC machines.

CO3: Construct sectional view sketches of core and shell types transformers using the design data. CO4: Construct Sectional view sketches of assembled DC machine and their parts using the design data.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme SEMESTER – VI

National Service Scheme (NSS)

(Common to all branches, Effective from the academic year 2024-25)

Course Code	**BNSK609**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Mandatory Course (Non-Credit)

(Completion of the course shall be mandatory for the award of degree)

Course Objectives: National Service Scheme (NSS) will enable the students to:

1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Module – 1

Introduction to NSS:

History and growth of NSS, Philosophy of NSS, Objectives of NSS, Meaning of NSS Logo, NSS Programs and activities, administrative structure of NSS, Planning of programs / activities, implementation of NSS programs / activities, National & State Awards for NSS College / Program Officer / Volunteers.

(04 Hours)

Module – 2

Overview of NSS Programs

Objectives, special camping – Environment enrichment and conservation, Health, Family, Welfare and Nutrition program. Awareness for improvement of the status of women, Social Service program, production-oriented programs, Relief & Rehabilitation work during natural calamities, education and recreations, Selection of the problem to be addressed.

(**04 Hours)**

Module – 3

NSS Activities - Group Contributions to Society / community (Activity based Learning):

Organic Farming, Indian agriculture (Past, Present, Future) Connectivity for marketing, Waste management– Public, Private and Govt. organization, 5 R's. Water conservation techniques – role of different stakeholders – implementation, preparing an actionable business proposal for enhancing the village income and approach for implementation. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education. **(06 Hours)**

Module – 4

NSS National Level Activities for Society / Community at large (Activity based Learning):

Developing Sustainable Water management system for rural areas and implementation approaches. Contribution to any national level initiative of Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.

(06 Hours)

Module – 5

NSS Individual Activities for Local Voice (Activity based learning)

Govt. school Rejuvenation and helping them to achieve good infrastructure, Plantation and adoption of plants. Know your plants. Spreading public awareness under rural outreach programs, National integration and social harmony events.

(06 Hours)

Course outcomes (Course Skill Set):

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

CO1: Understand the importance of his / her responsibilities towards society.

CO2: Analyse the environmental and societal problems/issues and will be able to design solutions for the same.

CO3: Evaluate the existing system and to propose practical solutions for the same for sustainable development.

CO4: Implement government or self-driven projects effectively in the field.

CO5: Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Teaching Practice:

- Classroom teaching (Chalk and Talk)
- ICT – Power Point Presentation
- Audio & Video Visualization Tools

Assessment Details

Weightage	CIE – 100%
Presentation -1 Selection of topic, PHASE-1	20 Marks
Commencement of activity and its progress – PHASE – 2	20 Marks
Case Study based Assessment – Individual performance	20 Marks
Sector wise study and its consolidation	20 Marks
Video based seminar for 10 minutes by each student at the end of the course with Report	20 Marks

Suggested Learning Resources:

Books:

1. NSS Course Manual**,** Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and its manual.
3. Government of India, NSS cell, Activities reports and its manual.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme SEMESTER - VI

Physical Education (Sports and Athletics)

(Common to all branches, Effective from the academic year 2024-25)

Course Code	**BPEK609**	CIE Marks	100
Teaching Hours/Week (L: T:P)	0:0:2	SEE Marks	--
Total Number of Contact Hours	26	Exam Hours	--

Mandatory Course (Non-Credit)

(Completion of the course shall be mandatory for the award of degree)

Course Objectives: The course will enable students to

1. Develop a healthy life style.
2. Acquire Knowledge about various stages of sports and games.
3. Focus on modern technology in sports.

Module – 1

Introduction of the game: Aim of sports and games, Brief history of the game, Nature of the game, Terminology & Modern trends of the game, Fitness & Skill tests along with Game Performance.

(06 Hours)

Module – 2

Offensive and Defensive Techno Tactical Abilities: Fitness, Fundamentals & Techniques of the game with the implementation of Biomechanics, Tactics- Drills for the Techno Tactical abilities, Individual and Group, Miner games- to implement the Techniques, Tactics and Motor abilities.

(05 Hours)

Module – 3

Team tactics and Rules of the Game: Rules and Regulations of the Game: Game rules as well as sequence of officiating, Team tactics: Offensive and Defensive team strategies and scrimmages, Practice Matches: among the group, Analysis of Techno Tactical abilities: Correction and implementation of skills and Sports Injuries and rehabilitation: First aid, PRICE treatment,

(05 Hours)

Module – 4

Sports Training: Introduction of Sports Training, Principles of Sports performance, how to increase and sustain the sports performance, Training Load & Recovery- How to increase the training load (volume/Intensity) and means and methods for Recovery, Periodization: Shorts, Medium and Long term, Physiological changes: Changes in Lung capacity, heart beats etc.

(05 Hours)

Module – 5

Organization of Sports Event: Tournament system, Planning and preparation for the competition, Ground preparation and Equipment's, Organizing an event among the group.

(05 Hours)

The above 5 modules are common to all the sports events / games, we are offering the following games**: 1. Baseball, 2. Kabaddi, 3. Table Tennis, and 4. Volleyball.**

Course outcomes:

The students will be able to:

1. Understand the importance of sports and games, inculcate healthy habits of daily exercise & fitness, Self-hygiene, good food habits, Create awareness of Self-assessment of fitness.
2. Develops individual and group techno tactical abilities of the game.
3. Increases the team combination and plan the strategies to play against opponents.
4. Outline the concept of sports training and how to adopt technology to attain high level performance.
5. Summarize the basic principles of organising sports events and concept of technology implemented to organise competitions in an unbiased manner.

Teaching Practice:

- Classroom teaching (Chalk and Talk)
- ICT – Power Point Presentation and video analysing.
- Practical classes in outdoor and indoor as per requirement.

CIE: 100 Marks

- CIE 1 for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester.
- CIE 2 for 60 marks – A practical test conducted at the end of the semester in which the student has to give fitness and skill tests and his performance in game will be assessed.

Textbooks:

1. Barbara Bushman, "ACSM's complete guide to Fitness & Health", 2011, Human Kinetics USA
2. Pankaj Vinayak Pathak, **"*Sports and Games - Rules and Regulation*", 2019, Khel Sahitya Kendra.**
3. Hardayal Singh, *"Sports Training, General Theory & Methods"***,** 1984 "Netaji Subhas, National Institute of Sports".
4. Keith A. Brown, "International Handbook of Physical Education and Sports Science", 2018, (5 Volumes) Hardcover.

References:

1. Tudor O Bompa,*" Periodization Training for Sports*", 1999, Human Kinetics, USA
2. Michael Boyle, "New Functional Training for Sports" 2016, Human Kinetics USA
3. Michael Kjaer, Michael Rogsgaard, Peter Magnusson, Lars Engebretsen & 3 more, "Text book of Sports Medicine: Basic Science and Clinical Aspects of Sports Injury and Physical Activity", 2002, Wiley Blackwell.
4. Scott L. Delp and Thomas K. Uchida, "Biomechanics of Movement: The Science of Sports, Robotics, and Rehabilitation", 2021, The MIT Press
5. MCARDLE W.D. "Exercise Physiology Nutrition Energy And Human Performance" 2015, LWW IE (50)

B.E ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme SEMESTER - VI

Yoga

(Common to all branches, Effective from the academic year 2024-25)

Course Code	**BYOK609**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Course Objectives:

This course will enable students to:

1. Understand the importance of practicing yoga in day-to-day life.
2. Be aware of therapeutic and preventive value of Yoga.
3. Have a focussed, joyful and peaceful life.
4. Maintain physical, mental and spiritual fitness.
5. Develop self-confidence to take up initiatives in their lives.

Module – 1

Introduction to Yoga: Introduction, classical and scientific aspects of yoga, Importance, Types, Healthy Lifestyle, Food Habits, Brief Rules, Sithalikarana Practical classes.

(04 Hours)

Module – 2

Physical Health: Introduction, Pre-requisites, Asana-Standing, Sitting, Supine and Prone, Practical classes.

(06 Hours)

Module – 3

Psychological Health: Introduction Thought Forms, Kriya (Kapalabhati), Preparation to Meditation, Practical classes.

(06 Hours)

Module – 4

Therapeutic Yoga: Mudra Forms, Acupressure therapy, Relaxation techniques Practical classes.

(06 Hours)

Module – 5

Spirituality & Universal Mantra: Introduction, Being Human, Universal Mantra, Universal LOVE, Benefits of practice of Spirituality in day-to-day life, practical classes.

(04 Hours)

Course Outcomes:

Students will be able to:

1. Understand the requirement of practicing yoga in their day-to-day life.
2. Apply the yogic postures in therapy of psychosomatic diseases
3. Train themselves to have a focussed, joyful and peaceful life.
4. Demonstrate the fitness of Physical, Mental and Spiritual practices.
5. Develops self-confidence to take up initiatives in their lives.

Teaching Practice:

- Classroom teaching (Chalk and Talk)
- ICT – Power Point Presentation

- Audio & Video Visualization Tools

CIE: 100 Marks

- CIE 1 for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester.
- CIE 2 for 60 marks – A practical test conducted at the end of the semester in which the student have to perform asanas.

Textbooks

1. George Feuerstein: The yoga Tradition (Its history, literature, philosophy and practice.)
2. Sri Ananda: The complete Book of yoga Harmony of Body and Mind. (Orient paper Backs: vision Books Pvt.Ltd., 1982.
3. B.K.S Iyenkar: Light on the Yoga sutras of patanjali (Haper Collins Publications India Pvt.,Ltd., New Delhi.)
4. Science of Divinity and Realization of Self – Vethathiri Publication, (6-11) WCSC, Erode

References

1. Principles and Practice of Yoga in Health Care, Publisher: Handspring Publishing Limited, ISBN: 9781909141209, 9781909141209
2. Basavaraddi I V: Yoga in School Health, MDNIY New Delhi, 2009
3. Dr. HR. Nagendra: Yoga Research and applications (Vivekanda Kendra Yoga Prakashana Bangalore)
4. Dr. Shirley Telles: Glimpses of Human Body (Vivekanda Kendra Yoga Prakashana Bangalore)

Web resources

Web links and Video Lectures (e-Resources): Refer links
1. https://youtu.be/KB-TYlgd1wE
2. https://youtu.be/aa-TG0Wg1Ls

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme SEMESTER - VI

National Cadet Course (NCC)

(Common to all branches, Effective from the academic year 2024-25)

Course Code	**BNCK609**	CIE Marks	100
Teaching Hours/Week (L: T:P)	0:0:2	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Mandatory Course (Non-Credit)

(Completion of the course shall be mandatory for the award of degree)

Course Objectives:

This course will enable students to:

- Understand the vision of NCC and its functioning.
- Understand the security set up and management of Border/Coastal areas.
- Acquire knowledge about the Armed forces and general awareness.

Module– 1

Introduction to National Cadet Corp: What is NCC, who can join NCC, benefits, Establishment, history, 3 wings, motto, core values, Aims, flag, song, pledge, cardinals, Organization, Director General NCC, Directorates, Uniform and Cadet ranks, Camps, Certificate exams, Basic aspects of drill.

National Integration: Importance of national integration**,** Factors affecting national integration, Unity in diversity**,** Role of NCC in nation building.

Disaster Management: What is a Disaster**,** Natural and Man-made disasters**,** Earthquake, Floods.

(04 Hours)

Module– 2

Indian Army:

Introduction to Indian Army, Command and control, Fighting & supporting arms**,** Rank structure, Major Regiments of the Army**,** Major Wars and Battles**,** Entry to the Indian Army, Renowned leaders and Gallantry Awardees.

(02 Hours)

Module– 3

Module– 4

Module– 5

Drill Practicals: Savdhan, Vishram, Salute, Turning, Marching.

(8 hours)

Course outcomes:

The students will be able to:

CO1: Develop qualities like character, comradeship, discipline, leadership, secular outlook, spirit of adventure, ethics and ideals of selfless service.

CO2: Get motivated and trained to exhibit leadership qualities in all walks of life and be always available for the service of the nation.

CO3: Familiarize on the issues related to social & community development and disaster management and equip themselves to provide solutions.

CO4: Get an insight of the defense forces and further motivate them to join the defense forces.

Teaching Practice:

- Blackboard/Multimedia Assisted Teaching.
- Class Room Discussions, Brainstorming Sessions, Debates.
- Activity: Organizing/Participation in Social Service Programs. On Ground: Drill training.

CIE: 100 Marks

- CIE 1 for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester.

CIE 2 for 60 marks – A practical test conducted at the end of the semester.

Textbooks:

1. NCC Cadets Handbook –Common Directorate General of NCC, New Delhi.
2. NCC Cadets Handbook –Special(A), Directorate General of NCC, New Delhi.

References:

- Chandra B. Khanduri, "Field Marshal KM Cariappa: a biographical sketch", Dev Publications,2000.
- Gautam Sharma, "Valour and Sacrifice: Famous Regiments of the Indian Army", Allied Publishers,1990.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER - VI

Music

(Common to all branches, Effective from the academic year 2024-25)

Course Code	**BMUK609**	CIE Marks	100
Teaching Hours/Week (L: T:P)	0:0:2	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Mandatory Course (Non-Credit)

(Completion of the course shall be mandatory for the award of the Degree)

Course Objectives:

The course will enable the students to:

1. Identify the major traditions of Indian music, both through notations and aurally.
2. Analyze the compositions with respect to musical and lyrical content.
3. Demonstrate an ability to use music technology appropriately in a variety of settings.

Module – 1

Preamble: Contents of the curriculum intend to promote music as a language to develop an analytical, creative, and intuitive understanding. For this the student must experience music through study and direct participation in improvisation and composition.

Origin of the Indian Music: Evolution of the Indian music system, Understanding of Shruthi, Nada, Swara, Laya, Raga, Tala, Mela. **(03 Hours)**

Module – 2

Compositions: Introduction to the types of compositions in Carnatic Music - Geethe, Jathi Swara, Swarajathi, Varna, Krithi, and Thillana, Notation system. **(03 Hours)**

Module – 3

Composers: Biography and contributions of Purandaradasa, Thyagaraja, Mysore Vasudevacharya. **(03 Hours)**

Module – 4

Music Instruments: Classification and construction of string instruments, wind instruments, percussion instruments, Idiophones (Ghana Vaadya), Examples of each class of Instruments **(03 Hours)**

Module – 5

Abhyasa Gana: Singing the swara exercises (Sarale Varase Only), Notation writing for Sarale Varase and Suladi Saptha Tala (Only in Mayamalavagowla Raga), Singing 4 Geethe in Malahari, and one Jathi Swara, One Nottu Swara OR One krithi in a Mela raga, a patriotic song **(14 Hours)**

Course Outcomes (COs):

The students will be able to:

CO1: Discuss the Indian system of music and relate it to other genres (Cognitive Domain) CO2: Experience the emotions of the composer and develop empathy (Affective Domain) CO3: Respond to queries on various patterns in a composition (Psycho-Motor Domain)

Teaching Practice:

- Classroom teaching
- ICT – PowerPoint Presentation
- Audio & Video Visualization Tools

CIE: 100 Marks

- **CIE 1** for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester
- **CIE 2** for 60 marks – A practical test conducted at the end of the semester in which the student has to recite one Sarale Varase mentioned by the examiner in three speeds. Sing / Play the Geethe in Malahari. Singing / Playing Jathi Swara / Krithi.

Textbooks

1. Vidushi Vasantha Madhavi, "Theory of Music", Prism Publication, 2007.
2. T Sachidevi and T Sharadha (Thirumalai Sisters), Karnataka Sangeetha Dharpana
    - Vol. 1 (English), Shreenivaasa Prakaashana, 2018.

References

1. Lakshminarayana Subramaniam, Viji Subramaniam, "Classical Music of India: A Practical Guide", Tranquebar 2018.
2. R. Rangaramanuja Ayyangar, "History of South Indian (Carnatic) Music", Vipanci
    a. Charitable Trust; Third edition, 2019.
3. Ethel Rosenthal, "The Story of Indian Music and Its Instruments: A Study of the Present and a Record of the Past", Pilgrims Publishing, 2007.
4. Carnatic Music, National Institute of Open Schooling, 2019.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

INDIAN KNOWLEDGE SYSTEM

(Common to All UG Programs)

Applicable for the Academic Year 2024-25 for 2022 scheme onwards

Course Code	**BIKS610**	CIE Marks	100
Teaching Hours/Week (L: T:P)	1:0:0- NCMC	SEE Marks	-
Total Number of Lecture Hours	13	Total marks	100

Course objectives:

1. To facilitate the students with the concepts of Indian traditional knowledge and to makethem understand the importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyse it and apply it to their day-to-day life.

Module – 1

Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus, Philosophy,Character, scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge. **(5 Hours)**

Module – 2

Traditional Knowledge in Humanities and Sciences: Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Tradein India and Engineering and Technology. **(4 Hours)**

Module – 3

Traditional Knowledge in Professional domain: Town planning and architecture-Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals. **(4 Hours)**

Course Outcomes:

After completing the course, the students will be able to

CO1: Provide an overview of the concept of the Indian Knowledge System and its importance.
CO2: Appreciate the need and importance of protecting traditional knowledge.
CO3: Recognize the relevance of Traditional knowledge in different domains.
CO4: Establish the significance of Indian Knowledge systems in the contemporary world.

Reference Books:

1. **Introduction to Indian Knowledge System- concepts and applications**, B Mahadevan,Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0
2. **Traditional Knowledge System in India**, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230,
3. **Knowledge Traditions and Practices of India**, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334,

Web Links:

- **https://www.youtube.com/watch?v=LZP1StpYEPM**
- **http://nptel.ac.in/courses/121106003/**
- http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
- **https://www.wipo.int/pressroom/en/briefs/tk_ip.htm**
- https://unctad.org/system/files/official-document/ditcted10_en.pdf
- http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf

- https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE