

RN SHETTY TRUST ®



ESTD.: 2001
An Institute with a Difference

RNS INSTITUTE OF TECHNOLOGY

Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi

Approved By AICTE, New Delhi. Accredited by NAAC 'A+' Grade

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Dr. R N Shetty
Founder



DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

BACHELOR OF ENGINEERING

Scheme and Syllabus of V - VIII Semesters

2024 SCHEME



www.rnsit.ac.in

Scheme and Syllabus

Batch 2024 – 2028

5th to 8th Semesters

(As per NEP – 2020)
(Effective from the Academic year 2024 – 25)

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About RNSIT

RNS Institute of Technology, familiar as RNSIT was established in the year 2001. It is the brainchild of Dr. R. N. Shetty, well known industrialist, and a great philanthropist. The institution was established with a sole purpose of imparting quality education in Engineering, Technology and Management. Being one of the premier engineering colleges in the country RNSIT is marching towards placing itself in the global map by excelling in academics and placements.

Lush green campus, state of the art infrastructure, well equipped laboratories, hundreds of activities, numerous new initiatives, consistent VTU ranks, path breaking placements, cultural extravaganza, Sports events, 4000 + students and 300 + faculty – with all these RNSIT has become dream destination for engineering aspirants across the country.

Founded by a great visionary Dr. R N Shetty, a renowned name in the industries viz construction, manufacturing, hotel, automobile, power & IT services, and education, RNSIT has been scripting history in the field of technical education. Right from its inception in the year 2001, the institution is showing exemplary growth with respect to academics, placements, sports and cultural activities. With 9 UG engineering branches, 4 PG courses and 9 R&D centres. RNSIT is aiming towards becoming the premier engineering institutes in the world.

Vision

Building RNSIT into a World Class Institution

Mission

To impart high quality education in Engineering, Technology and Management with a difference, enabling students to excel in their career by

- Attracting quality Students and preparing them with a strong foundation in fundamentals so as to achieve distinctions in various walks of life leading to outstanding contributions.
- Imparting value based, need based, choice based and skill based professional education to the aspiring youth and carving them into disciplined, World class Professionals with social responsibility.
- Promoting excellence in Teaching, Research and Consultancy that galvanizes academic consciousness among Faculty and Students.
- Exposing Students to emerging frontiers of knowledge in various domains and make them suitable for Industry, Entrepreneurship, Higher studies, and Research & Development.
- Providing freedom of action and choice for all the Stakeholders with better visibility.

About EEE Department

The Department of Electrical & Electronics Engineering at RNSIT was started in the year 2004 with a sanctioned intake of 60. The program is NBA accredited and the college is accredited by NAAC with an 'A+' grade. The department is headed by Dr. RoopaNayak who has specialized in the area of Industrial Drives, VLSI & Embedded System. The department has a total staff strength of 18, including teaching and non-teaching staff.

The well qualified and committed staff, along with the students of the department are working with the vision of making the department one of the best in India in both formal and non-formal education, and offering various research opportunities and services in Electrical Engineering over the next decade. The department provides an excellent learning environment supported by quality teaching with skilled faculty.

The students are well-trained with the support of the placement cell, subsequently paving the way for them in getting placed in top companies. The graduates have performed exceptionally well and achieved significant heights in their career prospects. The department has bagged a total of 13 VTU ranks (11 UG & 2 PG ranks) in VTU examinations till date.

The faculties of Electrical Engineering are involved in active research in the areas of Power Quality, Power System, Voltage Stability, Electric Drives, Power Electronics, Electric Vehicles and High Voltage Engineering. The focus of the department currently is to set up an R&D centre to enable teachers to work for their research purpose, along with undertaking industrial consultancy.

VISION

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Pursuit of excellence in the field of Electrical & Electronics Engineering

MISSION

- To prepare students to achieve core competence and academic excellence.
- To provide necessary skills to design, develop and solve complex problem in the field of Electrical & Electronics Engineering and contribute to technological growth.
- To make them ethical professionals/entrepreneur capable of adapting to changes in technologies, and contribute to society.
- To support students to develop leadership qualities, self-learning abilities, communication skills and teamwork skills.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Graduates of the Department shall

- **PEO 1** : have strong knowledge of core Electrical Engineering and Basic sciences to excel in their career
- **PEO 2**: be able to pursue career in multi-disciplinary areas involving core engineering subjects.
- **PEO 3** : have ability for lifelong learning, use modern tools, and contribute to Research and development in niche areas.
- **PEO 4** : have positive attitude, good communication skills and professional ethics

PROGRAM SPECIFIC OUTCOMES (PSOs)

The Graduates of the Department shall have the

- **PSO 1:** Ability to design, analyse, and model Electrical systems by applying the knowledge of Circuit Theory, Control Systems, Power Systems and Power Electronics.
- **PSO 2:** Ability to understand and apply latest technologies of Electrical Engineering to develop products useful for society and industry.
- **PSO 3:** Ability to provide eco friendly project solutions for Electrical Systems.

PROGRAM OUTCOMESREVISED (POs)

1. **PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5. **PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **PO8: Individual and Collaborative Teamwork:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
10. **PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **PO11: Life-Long Learning:** Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)



NOTE: "BIOLOGY FOR ENGINEERS" in 4th semester and "ENVIRONMENTAL STUDIES" in 5th semester

RN Shetty Trust ® RNS INSTITUTE OF TECHNOLOGY, BENGALURU – 560098 B.E in Electrical and Electronics Engineering Scheme of Teaching and Examinations Outcome Based Education (OBE) and Choice Based Credit System (CBCS) (Effective from the Academic Year 2024-25)													
5 th SEMESTER													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term work (TW) + Self Learning (SL) Hours Per Semester	EXAMINATION				CREDITS
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	HSMS	BEE501	ENGINEERING MANAGEMENT AND ENTREPRENEURSHIP	EEE	3	2	0	45	3	50	50	100	4
2	IPCC	BEE502	LINEAR CONTROL SYSTEMS	EEE	3	0	2	45	3	50	50	100	4
3	PCC	BEE503	POWER ELECTRONICS	EEE	3	2	0	45	3	50	50	100	4
4	PCCL	BEEL504	POWER ELECTRONICS LABORATORY	EEE	0	0	2	0	3	50	50	100	1
5	PEC	BEE515X	PROFESSIONAL ELECTIVE	EEE	3	0	0	45	3	50	50	100	3
6	PROJ	BEE586	MINI PROJECT	EEE	0	0	2	30	3	100	0	100	2
7	BSC	BENS507/ BBOE507	ENVIRONMENTAL STUDIES / BIOLOGY FOR ENGINEERS	CV/Biotech /Chemistry	2	0	0	30	2	50	50	100	2
8	AEC	BRMK557	RESEARCH METHODOLOGY AND IPR	EEE	2	0	0	30	2	50	50	100	2
9	MC	BNSK559	NATIONAL SERVICE SCHEME(NSS)	ANY DEPARTMENT	0	0	2	0					0
		BPEK559	PHYSICAL EDUCATION(PE) (SPORTS AND ATHLETICS)	PED									
		BYOK559	YOGA	PED									
TOTAL										550	350	900	22

PCC: Professional Core Course, **PCCL:** Professional Core Course laboratory, **UHV:** Universal Human Value Course, **MC:** Mandatory Course (Non-credit), **AEC:** Ability Enhancement Course, **SDC:** Skill Development Course, **L:** Lecture, **T:** Tutorial, **P:** Practical **SL:** Self Learning, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.
Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course.

PROFESSIONAL ELECTIVE COURSE (PEC)	
BEE515A	FUNDAMENTALS OF VLSI DESIGN
BEE515B	MACHINE LEARNING APPLICATIONS IN ELECTRICAL SYSTEMS
BEE515C	EMBEDDED SYSTEMS
BEE515D	FUEL CELL TECHNOLOGY

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SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term work (TW) + Self Learning (SL) Hours Per Semester	EXAMINATION				CREDITS	
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS		
1	IPCC	BEE601	POWER SYSTEM ANALYSIS-I	EEE	3	0	2	45	3	50	50	100	4	
2	PCC	BEE602	SIGNALS & DIGITAL SIGNAL PROCESSING	EEE	3	2	0	45	3	50	50	100	4	
3	PEC	BEE613X	PROFESSIONAL ELECTIVE COURSE	EEE	3	0	0	45	3	50	50	100	3	
4	OEC	BEE654X	OPEN ELECTIVE COURSE	EEE	3	0	0	45	3	50	50	100	3	
5	PROJ	BEE685	MAJOR PROJECT PHASE -I	EEE	0	0	4	0	3	100	0	100	2	
6	PCCL	BEEL606	SIGNALS AND DSP LABORATORY	EEE	0	0	2	0	3	50	50	100	1	
7	AEC	BEEL657	SIMULATION AND CONTROL OF POWER ELECTRONIC CIRCUITS	IF COURSE IS THEORY				15	2	50			100	1
				EEE	1	0	0							
				IF COURSE IS PRACTICAL					3					
8	MC	BIKS608	INDIAN KNOLEDGE SYSTEM	ANY DEPARTMENT	1	0	0	0	2	100			100	0
				ANY DEPARTMENT										
9	MC	BNSK659	NATIONAL SERVICE SCHEME(NSS)	ANY DEPARTMENT										0
		BPEK659	PHYSICAL EDUCATION(PE) (SPORTS AND ATHLETICS)	PED	0	0	2	0	2	100		100		
		BYOK659	YOGA	PED										
TOTAL										600	300	900	18	

PCC: Professional Core Course, **PCCL:** Professional Core Course laboratory, **UHV:** Universal Human Value Course, **MC:** Mandatory Course (Non-credit), **AEC:** Ability Enhancement Course, **SDC:** Skill Development Course, **L:** Lecture, **T:** Tutorial, **P:** Practical **SL:** Self Learning, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.
Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course.

PROFESSIONAL ELECTIVE COURSE (PEC)	
BEE613A	DIGITAL SYSTEM DESIGN USING VERILOG
BEE613B	FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLE
BEE613C	ADVANCED CONTROL SYSTEMS
BEE613D	BATTERY TECHNOLOGY & BATTERY MANAGEMENT
OPEN ELECTIVE COURSE (PEC)	
BEE654A	UTILISATION OF ELECTRICAL POWER
BEE654B	SOLAR AND WIND ENERGY
BEE654C	INDUSTRIAL SERVO CONTROL SYSTEMS
BEE654D	TESTING, COMMISSIONING AND CONDITION MONITORING OF ELECTRICAL EQUIPMENT



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Scheme A: 7 th SEMESTER (7 th and 8 th Semesters Swappable)													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term work (TW) + Self Learning (SL) Hours Per Semester	EXAMINATION				
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	CREDITS
1	IPCC	BEE701	POWER SYSTEM PROTECTION	EEE	3	0	2	45	3	50	50	100	4
2	IPCC	BEE702	POWER SYSTEM ANALYSIS-II	EEE	3	0	2	45	3	50	50	100	4
3	PCC	BEE703	INDUSTRIAL DRIVES AND APPLICATIONS	EEE	3	2	0	45	3	50	50	100	4
4	PEC	BEE714X	PROFESSIONAL ELECTIVE COURSE	EEE	3	0	0	45	3	50	50	100	3
5	OEC	BEE755X	OPEN ELECTIVE COURSE	EEE	3	0	0	45	3	50	50	100	3
6	PROJ	BEE786	MAJOR PROJECT PHASE - 2	EEE	0	0	12	0	3	100	100	200	6
TOTAL										350	350	700	24

PCC: Professional Core Course, **PCCL:** Professional Core Course laboratory, **UHV:** Universal Human Value Course, **MC:** Mandatory Course (Non-credit), **AEC:** Ability Enhancement Course, **SDC:** Skill Development Course, **L:** Lecture, **T:** Tutorial, **P:** Practical **SL:** Self Learning, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.
Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course.

PROFESSIONAL ELECTIVE COURSE (PEC)	
BEE714A	POWER SYSTEM PLANNING
BEE714B	HIGH VOLTAGE ENGINEERING
BEE714C	ENERGY AUDIT & ENERGY MANAGEMENT SYSTEM
BEE714D	SMART GRID
OPEN ELECTIVE COURSE (PEC)	
BEE755A	FUNDAMENTALS OF ELECTRIC VEHICLE
BEE755B	ENERGY CONSERVATION AND AUDIT
BEE755C	PLC & SCADA
BEE755D	SENSORS AND TRANSDUCERS

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Scheme A: 8 th SEMESTER (7 th and 8 th Semesters Swappable)													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term work (TW) + Self Learning (SL) Hours Per Semester	EXAMINATION				
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	CREDITS
1	PEC	BEE811X	PROFESSIONAL ELECTIVE COURSE (ONLINE)	EEE	3	0	0	45	3	50	50	100	3
2	OEC	BEE852X	OPEN ELECTIVE COURSE (ONLINE)	EEE	3	0	0	45	3	50	50	100	3
3	INT	BEE803	INTERNSHIP (INDUSTRY/RESEARCH-MINIMUM 14 WEEKS)	EEE	0	0	20	0	3	100	100	200	10
TOTAL										200	200	400	16

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Scheme B: 7 th and 8 th SEMESTERS (VII and VIII Semesters for the candidates who seek an internship with project work)													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term work (TW) + Self Learning (SL) Hours Per Semester	EXAMINATION				
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	CREDITS
1	IPCC	BEE701	TO BE COMPLETED IN 5TH/6TH SEMESTER	EEE	3	0	2	45	3	50	50	100	4
2	IPCC	BEE702	TO BE COMPLETED IN 5TH/6TH SEMESTER	EEE	3	0	2	45	3	50	50	100	4
3	PCC	BEE703	TO BE COMPLETED IN 5TH/6TH SEMESTER	EEE	3	2	0	45	3	50	50	100	4
4	PEC	BEE714X	PROFESSIONAL ELECTIVE COURSE	EEE	3	0	0	45	3	50	50	100	3
5	OEC	BEE755X	OPEN ELECTIVE COURSE	EEE	3	0	0	45	3	50	50	100	3
1	PEC	BEE811X	PROFESSIONAL ELECTIVE COURSE (ONLINE)	EEE	3	0	0	45	3	50	50	100	3
2	OEC	BEE852X	OPEN ELECTIVE COURSE (ONLINE)	EEE	3	0	0	45	3	50	50	100	3
3	PROJ	BEE883	MAJOR PROJECT PHASE - 2	EEE	0	0	12	0	3	100	100	200	8
4	INT	BEE804	INTERNSHIP (INDUSTRY/RESEARCH) 02 (SEMESTERS)	EEE	0	0	20	0	3	100	100	200	10
TOTAL										550	550	1100	42

Note: VII and VIII Semesters of IV Year of the Program

1. Institutions can swap the VII and VIII semester Schemes of Teaching and Examinations to accommodate research internships/industry internships after the VI semester.
2. Credits earned for the courses of VII and VIII semester Schemes of Teaching and Examinations shall be counted against the corresponding semesters, whether the VII or VIII semester is completed during the beginning of the IV year or the later part of the IV year of the program.



V SEMESTER SUBJECTS

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B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Engineering Management and Entrepreneurship		
Course Code:	BEE501	CIE MARKS	50
(L: T: P) +(SL)	(3:2:0) +(45 Hours / Semester)	SEE MARKS	50
Credits:	4	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: - Understand the basic skills of management. - Understand the need for entrepreneurs and their skills. - Identify the management functions and social responsibilities. - Understand the identification of business, drafting the business plan and sources of funding.			
Module-1			9 Hours
Management: Nature and Functions of Management: Importance of Management, Definitions of Management, Management functions or Process of Management, Levels of Management, Roles of a Manager, Managerial Skills, Management and Administration, Management as a Science, Art and Profession. Planning: Nature and Importance of Planning, Types of Plans, steps in Planning, Limitations of Planning, making planning effective, Decision Making – Meaning, Types of Decisions-Steps in Decision Making.			
Module-2			9 Hours
Organizing : Meaning and Characteristics of Organization, Process of Organizing, Principles of Organizing, Departmentalization: Process of departmentalization, Purpose of departmentalization, Committees: meaning, Types of Committees, Advantages and Weakness of committees, Delegation of Authority: Meaning, Guidelines, Advantages of effective Delegation, Decentralization of Authority Meaning, Distinction between Delegation and Decentralization. Staffing Directing and Controlling: Importance and need for proper Staffing, Importance of selection process, steps in selection procedure. Directing: Meaning, Requirements of effective direction, Motivation: Meaning, Motivation Theories, Controlling: Need, Benefits and steps of control system.			
Module-3			9 Hours
Communication and Leadership: Meaning, Importance and purpose of Communication, Forms of Communication. Principles of effective Communication, Barriers to Communication. Leadership: Meaning, Characteristics of leadership, Behavioral approach of leadership, Leadership effectiveness, Leadership styles in Indian Organizations. Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance.			

Module-4	9 Hours
Entrepreneurship: Entrepreneurship, Introduction, evolution of the concept of entrepreneurship, Entrepreneurship today types of entrepreneurs, Entrepreneurial competencies, capacity building for entrepreneurs. Models for opportunity evaluation. Identification of business opportunities: Introduction mobility of entrepreneurs, Business opportunities in India. Modern Small Business Enterprises: Role of Small Scale Industries, Concepts and definitions of SSI Enterprises, Problems for Small Scale Industries, Impact of Globalization on SSI.	
Module-5	9 Hours
Business plans: Introduction purpose of a business plan, contents of a business plan, presenting a business plan, why do some business plan fail? Procedure for setting up an enterprise. Institutional Support for Business Enterprises: Central-Level Institutions: National board for micro small and medium enterprise, NBMSME, National Small Industries Corporation NSIC, State Level Institutions: State financial Corporations SFC, State Directorate Industries and Commerce SDIC, State Industrial Development Corporation SIDC, State Industrial Area Development Board SIADB, Technical consultancy Organization TCO, Non-government organizations.	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the fundamental concepts of Management and its functions.
CO2	Understand different functions to be performed by managers/Entrepreneurs.
CO3	Understand the social responsibilities of a business.
CO4	Understand the concepts of Entrepreneurship and to identify business opportunities.
CO5	Understand the components in developing a business plan and awareness about

ASSESSMENT DETAILS (Both CIE and SEE)

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

1. Principles of Management, P.C.Tripathi, P.N.Reddy, McGraw Hill, 6th Edition, 2017.
2. Entrepreneurship Development And Small Business Enterprises, Poornima, M.Charanthimath, Pearson, 2nd Edition, 2014. Reference Book.

Reference Books:

1. Dynamics of Entrepreneurial Development and Management, Vasant Desai, Himalaya Publishing House, 2007.
2. Essentials of Management: An International, Innovation and Leadership Perspective, Harold Koontz, Heinz Weihrich, McGraw Hill, 10th Edition, 2016

B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Linear Control Systems		
Course Code:	BEE502	CIE MARKS	50
(L:T:P) + (SL)	(3:0:2) + (45 Hours / Semester)	SEE MARKS	50
Credits:	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: - To understand modelling of physical systems and obtain the transfer function - To understand time domain response and estimate transient parameters and errors in steady state conditions - To use Routh-Hurwitz and Root locus techniques to determine stability of linear systems - To use Bode plot techniques to determine stability of linear systems - To understand use of state space analysis as a modern control theory concept to analyse linear systems			
Module-1: Mathematical Modelling and Block Diagram			9 Hours
Introduction to Control system and Classification of control system. Mathematical modelling: Modelling of mechanical system elements, electrical systems, Analogous systems, servomotors- modelling of armature controlled and field-controlled servomotors. Block diagram: Block diagram of a closed loop system, procedure for drawing block diagram			
Module-2: Signal flow graphs and Time domain analysis			9 Hours
Signal flow graphs: Construction of signal flow graphs, basic properties of signal flow graph, Mason's gain formula to find transfer function. Time Domain Analysis: Standard test signals, time response of first and second order systems, Time domain specifications, static error constants and steady state errors. Self-Learning Component: P, PI, PD, PID Controller			
Module-3: Stability analysis using Routh Hurwitz Criteria and Root locus			9 Hours
Routh Stability criterion: BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems. Root locus technique: Introduction, root locus concepts, rules for the construction of root locus , construction of root loci. Self-Learning Component: Effect of addition of pole and zero			
Module-4: Stability analysis in Frequency domain			9 Hours
Frequency Response analysis: Co-relation between time and frequency response – 2nd order systems only. Bode plots: Basic factors $G(j\omega) / H(j\omega)$, General procedure for constructing bode plots, computation of gain margin and phase margin. Self-learning component: Compensators			

Module-5: State Space Representation		9 Hours
Introduction, Concepts of state, state variables and state model, State models of Linear continuous time systems, State space representation using physical variables, Solution of state equations, Properties of state transition matrix, Computation of state transition matrix by Laplace Transformation .		
Practical Component of IPCC		
Sl No.	Experiments (Using Hardware components & MATLAB Simulation (Experiment 6-10))	
1.	Obtain the speed torque characteristics of (i) AC servo motor (ii) DC servo motor	
2.	Experiment to determine frequency response of a second order system	
3.	(a) Design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. (b) Determine experimentally the transfer function of the lag compensating network.	
4.	(a) 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.	Obtain the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.	
6.	a. To simulate a typical second order system and determine step response and evaluate time response specifications. b. To evaluate the effect of additional poles and zeros on time response of second order system. c. To evaluate the effect of pole location on stability d. To evaluate the effect of loop gain of a negative feedback system on stability.	
7.	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.	
8.	Verify the effect of input waveform, loop gain and system type on steady state errors.	
9.	To study the effect of open loop, gain on transient response of closed loop system using root locus.	
10.	(a) To study the effect of open loop poles and zeros on root locus contour (b) Comparative study of Bode and root locus with respect to stability.	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Model and analyze electrical systems and mechanical systems.
CO2	Formulate transfer functions using block diagram and signal flow graphs.
CO3	Evaluate time domain specifications and analyze the stability of control system including root locus.
CO4	Evaluate frequency domain specifications and analyze the performance of control system using Bode plot.
CO5	Analyze control system using state space model.

ASSESSMENT DETAILS (Both CIE and SEE)

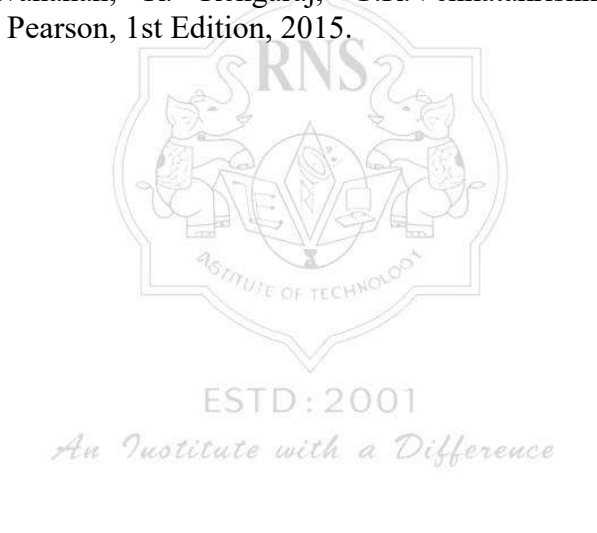
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall before 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D

- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.

Suggested Learning Resources:

Text Books

1. I. J. Nagarath and M. Gopal, Control Systems Engineering, New Age, 5th Edition, 2007.
2. Benjamin C Kuo, Farid Golnaraghi, "Automatic Control System", Wiley, 9th Edition, 2010
3. Ashfaq Husain, Haroon Ashfaq, "Control Systems", Dhanpat Rai & Co., 1st Edition, reprint 2017
4. M. Gopal, "Control Systems: Principles and Design", McH, 4th Edition, 2012
5. S. Salivahanan, R. Rengaraj, G.R. Venkatakrishnan, "Control System Engineering", Pearson, 1st Edition, 2015.



B.E. (Electrical and Electronics Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – V			
Course Title:	Power Electronics		
Course Code:	BEE503	CIE MARKS	50
(L: T: P) +(SL)	(3:2:0)+(45 Hours / Semester)	SEE MARKS	50
Credits:	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to:			
• To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics • To explain power diode characteristics, types, their operation and the effects of power diodes on RL circuits and the techniques for design and analysis of single phase diode rectifier circuits. • .To explain different power transistors, their steady state and switching characteristics and imitations. • To explain different types of Thyristors, their gate characteristics and gate control requirements. • To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.			
Module – 1		9 Hours	
Introduction: Applications of Power Electronics, Ideal Characteristics of switches Characteristics of practical devices; Specifications of Switches, control characteristics of power devices, Types of Power Electronic Circuits, Peripheral Effects, Intelligent Modules. Power Diodes: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types: Silicon Carbide (SiC), Gallium Nitride (GaN),. Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL and RLE load, Single-Phase Full- Wave Rectifiers with R, RL and RLE load, Single-Phase Full-Wave Rectifier with highly inductive Load. Performance parameters.			
Module – 2		9 Hours	
Power Transistors: Introduction, Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, Power MOSFETs – Steady State Characteristics, Switching Characteristics, IGBTs; BJT Base Drive, MOSFET Gate Drive, Isolation of Gate and Base Drives, Pulse transformers and Optocouplers. Types of Transistors			
Module – 3		9 Hours	
Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn- On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dt Protection, dv/dt Protection, Thyristor Firing Circuits, Unijunction Transistor. Programmable UJT			

Module – 4	9 Hours
Controlled Rectifiers: Introduction, Applications Single phase half wave circuit with R, RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with R, RL and RLE Load, Single-Phase Dual Converters, Three phase half wave circuit with R and RL Load. Three phase full wave circuit with R and RL Load. AC Voltage Controllers: Introduction, Applications Principle of phase control & Integral cycle control, Single-Phase Full- Wave Controllers with R and RL loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three- Phase Full-Wave Controllers.	
Module – 5	9 Hours
DC-DC Converters: Introduction, Applications, principle of step down chopper with R and RL load; principle of step up chopper with R load, Control strategies, performance parameters, DC-DC converter classification. DC-AC Converters: Introduction, Applications principle of operation single phase bridge inverters, performance parameters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters.	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the operating Principles, characteristics and switching behaviour of power semiconductor devices such as Diodes, SCR, MOSFET, IGBT, DIAC, TRIAC and GTO
CO2	Apply the concept of diode rectifiers and determine performance parameters
CO3	Analyze the operation of phase controlled rectifiers for different types of loads and determine the performance parameters.
CO4	Explain steady state characteristics, switching characteristics and limitations of different power transistors.
CO5	Explain the operating Principles, characteristics and switching behaviour of thyristors, their gate characteristics and gate control requirements.
CO6	Evaluate the performance parameters of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers when applied to different loads,

ASSESSMENT DETAILS (Both CIE and SEE)

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.

Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text book 1

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

Reference Books

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

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Power Electronics Laboratory		
Course Code:	BEEL504	CIE MARKS	50
(L: T: P) + (SL)	(0:0:2) + (0 Hours / Semester)	SEE MARKS	50
Credits:	1	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: - To conduct experiments on semiconductor devices to obtain their static characteristics. - To study different methods of triggering the SCR - To study the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads. - To control the speed of a DC motor, universal motor and stepper motors. - To study single phase full bridge inverter connected to resistive load.			
Sl No	Experiments		
1	Static Characteristics of SCR.		
2	Static Characteristics of MOSFET and IGBT.		
3	Characteristic of TRIAC.		
4	SCR turn on circuit using synchronized UJT relaxation oscillator.		
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.		
6	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without freewheeling diode		
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.		
8	Speed control of DC motor using single phase semi converter.		
9	Speed control of stepper motor.		
10	Speed control of universal motor using ac voltage regulator.		
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.		
12	Single phase MOSFET/IGBT based PWM inverter.		

COURSE OUTCOMES

CO1	Identify power semiconductor devices (SCR, IGBT and MOSFET) and demonstrate their static and switching characteristics using appropriate experimental setups
CO2	Analyse different triggering circuits for SCR and TRIAC
CO3	Construct and test the performance of single phase controlled full wave rectifier with R, RL load and RL with free wheeling diode, semi-converter with motor load and AC voltage controller with R load.
CO4	Implement speed control of a DC motor and universal motor, using chopper and AC Voltage Controller
CO5	Verify the performance of single phase full bridge inverter connected to resistive load.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Continuous Internal Evaluation (CIE):

- CIE marks for the practical course is 50 Marks.
- The split-up of CIE marks for record/ journal and test are in the ratio 60:40.
- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up, conduction of experiments by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Marks awarded for weekly conduction of experiments and submission of laboratory records evaluated for 30 marks.
- Record should contain all the specified experiments in the syllabus.
- Total marks scored by the students are scaled down to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests, each for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, write-up, procedural knowledge, conduction of experiments and acceptable result will carry a weightage of 80% and the rest 20% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to 20 marks (40% of maximum marks).
- The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.
- The minimum marks to be scored in CIE are 20 out of allotted 50 marks to appear for SEE, with minimum of 40% scored in every component of CIE.

Semester End Evaluation (SEE):

- SEE marks for the practical course is 50 Marks.
- All laboratory experiments are to be included for practical examination.
- Break up (Rubrics) of marks strictly adhered to by the examiners.
- Students can pick up one question (experiment) from the questions lot prepared by the internal/external examiners jointly.
- Evaluation of test write-up, conduction procedure, result and viva-voce will be conducted jointly by examiners. General rubrics suggested for SEE are, for write-up-20%, procedure, conduction and result – 60%, viva-voce-20% of maximum marks.
- SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled

down to 50 marks. (However, based upon course type, rubrics shall be decided by the examiners).

- Change of experiment is allowed only once and 20% marks allotted to the procedure part to be made zero.
- The duration of SEE is 03 hours.



B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Fundamentals of VLSI Design		
Course Code:	BEE515A	CIE MARKS	50
(L :T : P)+SL	(3:0:0)+ 45 Hours/Semester	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Impart knowledge of MOS transistors theory and CMOS technology. 2. Understand the basic electrical properties of MOS and BiCMOS circuits. 3. Understand the concept of subsystem design and layout processes. 4. Understand the concept of design process of computational elements			
Module-1			9 Hours
Introduction: Moore's law, speed power performance, nMOS fabrication, CMOS fabrication: n-well, p-well processes, BiCMOS, Comparison of bipolar and CMOS. Basic Electrical Properties of MOS And BiCMOS Circuits: Drain to source current versus voltage characteristics, threshold voltage, transconductance.			
Module-2			9 Hours
Basic Electrical Properties of MOS And BiCMOS Circuits: nMOS inverter, Determination of pull up to pull down ratio, nMOS inverter driven through one or more pass transistors, alternative forms of pull up, CMOS inverter, BiCMOS inverters, latch up. Basic Circuit Concepts: Sheet resistance, area capacitance calculation, Delay unit, inverter delay, estimation of CMOS inverter delay, driving of large capacitance loads, super buffers, BiCMOS drivers.			
Module-3			9 Hours
MOS and BiCMOS Circuit Design Processes: MOS layers, stick diagrams, nMOS design style, CMOS design style, design rules and layout, λ - based design. Scaling of MOS Circuits: scaling factors for device parameters, limitations of scaling.			
Module-4			9 Hours
Subsystem Design and Layout-1 : Switch logic pass transistor, Gate logic inverter, NAND gates, NOR gates, pseudo nMOS, Dynamic CMOS, example of structured design, Parity generator, Bus arbitration, multiplexers, logic function block, code converter. Subsystem Design and Layout-2 : Clocked sequential circuits, dynamic shift registers, bus lines, subsystem design processes, General considerations, 4-bit arithmetic processes, 4-bit shifter.			
Module-5:			9 Hours
Design Process-Computational Elements: Regularity, design of ALU subsystem, ALU using adders, carry look ahead adders, Multipliers, serial parallel multipliers, Braun array,			

Bough – Wooley multiplier.

Memory, Register and Aspects of Timing: Three Transistor Dynamic RAM cell, Dynamic memory cell, Pseudo- Static RAM, JK Flip flop, D Flip-flop circuits, RAM arrays, practical aspects and testability: Some thoughts of performance, optimization and CAD tools for design and simulation

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the fundamentals of MOS transistors (nMOS, pMOS) and basic fabrication process
CO2	Understand basic electrical properties and circuit concepts of MOS and BICMOS
CO3	Develop stick diagrams and apply lambda based design rules to develop physical layouts for nMOS and CMOS circuits
CO4	Apply the concept of subsystem design to combinational and clocked sequential circuits
CO5	Understand the design process of computational elements, memory and registers

ASSESSMENT DETAILS (Both CIE and SEE)

3 -Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.

CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			
Question Paper for SEE Theory SEE will be conducted by the college as per the scheduled time table, with common question papers for the course (duration 03 hours) - The question paper will have 10 questions with a choice between every pair of questions set for each module. Each question is set for 20 Marks. - There will be 2 questions from each module. Each of the 2 questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. - The students have to answer 5 full questions, selecting one full question from each module. - Marks scored by the student shall be proportionately scaled down to 50 Marks			
Suggested Learning Resources: Text Books - Basic VLSI Design -3rd Edition, Douglas A Pucknell, Kamaran Eshraghian, Prentice Hall of India publication, 2005. - CMOS Digital Integrated Circuits, Analysis And Design, 3rd Edition, Sung – Mo (Steve) Kang, Yusuf Leblebici, Tata McGraw Hill, 2002. - VLSI Technology - S.M. Sze, 2nd edition Tata McGraw Hill, 2003.			

B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Machine Learning applications in Electrical systems		
Course Code:	BEE515B	CIE MARKS	50
(L :T : P)+SL	(3:0:0)+ 45 Hours/Semester	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. To understand the basic theory underlying machine learning, types, and the process. 2. To become familiar with data and visualize univariate, bivariate, and multivariate data using statistical techniques and dimensionality reduction. 3. To understand various machine learning algorithms such as similarity-based learning, regression, decision trees, and clustering. 4. To familiarize with learning theories, probability-based models, and reinforcement learning, developing the skills required for decision-making in dynamic environments.			
Module-1		9 Hours	
Introduction to Machine Learning: Introduction, Need for Machine learning, Machine learning explained, Machine Learning in relation to other fields, Types of Machine Learning, Challenges of Machine Learning, Machine Learning Process. Machine learning application. Sample Program: 1. Write a Python program to analyze and visualize the data using NumPy and matplotlib Modules Write a Python Program to represent and analyze data using the Scikit-learn package			
Module-2		9 Hours	
Understanding Data: What is Data?, Big Data Analytics and Types of Analytics, Descriptive Statistics, Univariate Data Analysis and Visualization, Bivariate Data and Multivariate Data. Multivariate Statistics, Essential Mathematics for Multivariate Data. Overview of Hypothesis, Feature Engineering and Dimensionality Reduction Techniques. Sample Program: 1. Perform univariate, bivariate, and multivariate analysis on a real-world dataset (Iris dataset). Analyze residential or industrial electrical load data to understand energy consumption trends and perform statistical analysis. Use the Individual household electric power consumption dataset (available on UCI Machine Learning Repository) or simulated smart meter data.			
Module-3		9 Hours	
Similarity-based Learning: Introduction to Similarity or Instance-based Learning, Nearest Neighbor Learning, Weighted K-Nearest-Neighbor Algorithm, Nearest Centroid Classifier, Locally Weighted Regression (LWR). Regression Analysis: Introduction to Regression, Introduction to Linearity, Correlation, and			

Causation, Introduction to Linear Regression, Validation of Regression Methods, Multiple Linear Regression, Polynomial Regression, Logistic Regression, Ridge, Lasso and Elastic Net Regression.

Sample Programs:

1. Develop a ML Model to predict home prices using Linear Regression method (Source:USA_Housing.csv)

Develop a ML model for Electricity-Generation-Analysis-and-Prediction-in-India by Linear regression (Source: energygen.csv)

Module-4

9 Hours

Decision Tree Learning: Introduction to Decision Tree learning model, Decision Tree Induction Algorithms, Validating and pruning of decision trees.

Bayesian Learning: Introduction to Probability-based Learning, Fundamentals of Bayes Theorem, Classification Using Bayes Model. Naïve Bayes Algorithm for continuous attributes.

Sample Program:

1. Develop a decision tree model to analyze the voltage and current patterns across the three phases of the transmission lines to detect faults.

Develop a Naive Bayes classification model to predict the probability of a battery fault based on various battery parameters logged from an EV Battery Management System (BMS).

Module-5:

9 Hours

Clustering Algorithms: Introduction to Clustering approaches, Proximity Measures, Hierarchical clustering Algorithms, Partitional Clustering Algorithm.

Reinforcement Learning: Overview and Scope of Reinforcement Learning, Reinforcement learning as machine learning, Components of Reinforcement Learning, Q-Learning.

Sample Programs:

1. Use K-Means clustering to group electricity consumers into distinct categories based on their daily or hourly load profiles. This helps utilities design demand response strategies, pricing models, or infrastructure planning.
Use Q-Learning, a reinforcement learning algorithm, to optimize the charging schedule of an electric vehicle to minimize cost and avoid peak grid load hours.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Apply artificial intelligence concepts to model problem-solving agents and implement uninformed and heuristic search algorithms for solving AI problems.
CO2	Analyze and interpret univariate, bivariate, and multivariate data using statistical methods, feature engineering, and dimensionality reduction techniques.
CO3	Develop supervised learning models using similarity-based learning,

	regression techniques, decision trees, and Bayesian classifiers for classification and regression tasks.
CO4	Design and evaluate unsupervised and reinforcement learning models, including clustering techniques and Q-learning, to solve real-world decision-making problems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20		Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books

1. S Sridhar and M Vijayalakshmi, “Machine Learning”, Oxford University Press, 2021.
2. M N Murty and Ananthanarayana V S, “Machine Learning: Theory and Practice”, Universities Press (India) Pvt. Limited, 2024.

Reference Books :

1. Aurelien Geron, "Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly Media, 2nd Edition, 2019
2. Tom Mitchell, Machine Learning, McGraw Hill, 2017.
3. Yuxi (Hayden) Liu, "Python Machine Learning by Example", Packet Publishing Limited, 2017.



B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Embedded Systems		
Course Code:	BEE515C	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> • Introductory topics of Embedded System design • Characteristics & attributes of Embedded System • Introduction of Embedded System Software and Hardware development • RTOS based Embedded system design			
Module-1		9 Hours	
Introduction: Embedded Systems and general purpose computer systems, history, classifications, applications and purpose of embedded systems (Chapter 1 – Text 1) Core of Embedded Systems : Microprocessors and microcontrollers, RISC and CISC controllers, Big endian and Little endian processors, Application specific ICs, Programmable logic devices, COTS, sensors and actuators, communication interface, embedded firmware, other system components, PCB and passive components (Chapter 2 – Text 1)			
Module-2		9 Hours	
Characteristics and quality attributes of embedded systems: Characteristics, Operational and nonoperational quality attributes, application specific embedded system - washing machine, domain specific – automotive (Chapter 3 & 4 – Text 1)			
Module-3		9 Hours	
Hardware Software Co design and Program Modelling : Fundamental issues in Hardware Software Co-design, Computational models in Embedded System Design (Chapter 7 – Text 1: 7.1, 7.2) Embedded Hardware Design and Development: Analog Electronic Components, Digital Electronic Components, VLSI & Integrated Circuit Design, Electronic Design Automation Tools (Chapter 8 – Text 1: 8.1, 8.2, 8.3, 8.4)			
Module-4		9 Hours	
Embedded Firmware Design and Development: Embedded Firmware Design Approaches, Embedded Firmware Development Languages (Chapter 9 – Text 1: 9.1, 9.2) Embedded System Development Environments: Types of files generated on cross compilation (only explanation – programming codes need not be dealt), disassemble/decompiler, Simulators, Emulators and Debugging (Chapter 13 – Text 1: 13.2, 13.3,13.4)			
Module-5		9 Hours	
Real-time Operating System(RTOS) based Embedded System Design: Operating System basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling (Chapter 10 – Text 1: 10.1 to 10.5).			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	To explain characteristics of Embedded System design
CO2	To analyse embedded system software and hardware requirements
CO3	To develop programming skills in embedded systems for various applications
CO4	To design basic embedded system for real time applications.
CO5	To acquire knowledge about basic concepts of circuit emulators, debugging and RTOS

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

(A+B+C)

- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.

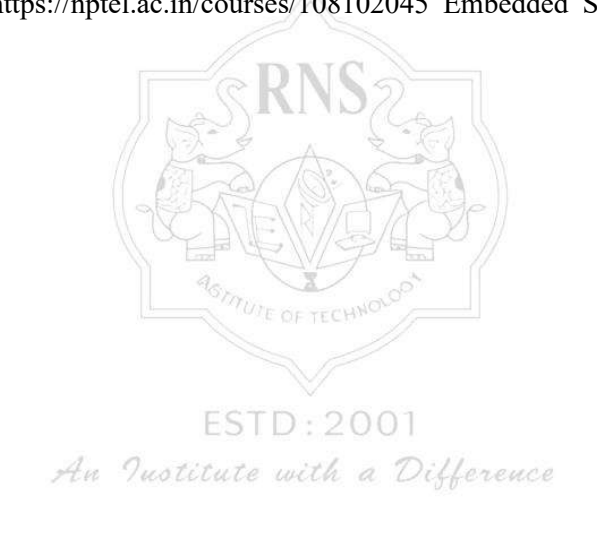
Suggested Learning Resources:

Text Books :

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

Web links and Video Lectures (e-Resources):

1. NPTEL Lectures: <https://nptel.ac.in/courses/108102045> Embedded Systems, IIT Delhi, Prof. Santanu Chaudhary



B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – V			
Course Title:	Fuel Cell Technology		
Course Code:	BEE515D	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES:			
1. To understand the importance of fuel cell technology and to have the fundamental knowledge required for its development. 2. To understand the reaction kinetics and modeling of fuel cells. 3. To understand the impact of fuel cells on environment. 4. To understand the various fundamental processes occurring in fuel cells.			
Module-1			9 Hours
OVERVIEW OF FUEL CELLS & THERMODYNAMICS: A simple fuel cell, Advantages and disadvantages, Fuel cell types, Basic operation, Performance characterization and modeling, Fuel cell technology, Fuel cells and the environment, Thermodynamics review, Enthalpy of reaction, Gibbs free energy, Reversible cell voltage, Fuel cell efficiency, Thermal and mass balances, Thermodynamics of reversible fuel cells			
Module-2			9 Hours
FUEL CELL REACTION KINETICS & MODELLING: Electrode kinetics, over voltages, Tafel equation, and charge, transfer reaction, exchange currents, electro-catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte, Basic fuel cell model, One-dimensional models, Computational Fluid Dynamics (CFD) models.			
Module-3			9 Hours
FUEL CELL CHARGE & MASS TRANSPORT: Charge transport mechanisms, Voltage losses, Transport resistance Conductivity, Electrolyte classes, Diffusivity and conductivity Ion conduction in oxide electrolytes, Transport in electrodes, Diffusion, Convective transport Mass transport limitations			
Module-4			9 Hours
FUEL CELL CHARACTERIZATION & PROCESSING SUB-SYSTEM DESIGN: characterization techniques, In-situ and ex-situ characterization, techniques, i-V curve, Frequency response analyses of Fuel cell, Fuel reforming, Water-gas shift reactors, Carbon monoxide cleanup, Efficiency losses, Reactor design.			
Module-5			9 Hours
BALANCE OF PLANT & ENVIRONMENTAL IMPACTS: Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells, Life Cycle Assessment (LCA), Greenhouse gas emissions, Air pollution impacts, Scenario analysis,			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	To explain types of fuel cells and its applications.
CO2	To understand the various fundamental processes occurring in fuel cells and working principle of fuel cells.
CO3	To apply various fundamentals of thermodynamics, chemical kinetics, and fluid mechanics to fuel cells.
CO4	To determine the impact of fuel cells on the environment using life cycle assessment.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books :

1. Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).
2. Bard, A. J. , L. R., Faulkner, Electrochemical Methods, Wiley, N.Y. (2004)
3. Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y. (2007).
4. Liu, H., Principles of fuel cells, Taylor & Francis, N.Y. (2006).

Reference Books:

1. M. M. MENCH, Fuel Cell Engines, Wiley, 2008.
2. M.T.M. Koper (ed.), Fuel Cell Catalysis, Wiley, 2009.
3. J.O'M. Bockris, A.K.N. Reddy, Modern Electrochemistry, Springer 1998.



B.E. (Electrical and Electronics Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – IV / V			
Course Title:	Environmental Studies		
Course Code:	BENS407 / 507	CIE MARKS	50
(L : T : P)+ SL	(2:0:0) + (30 Hours/Sem)	SEE MARKS	50
Credits:	2	EXAM HOURS	2
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is to facilitate the learner to:</i>			
• Introduce the basic concepts of ecology and ecosystem functioning, including biodiversity and biogeochemical cycles. • Understand various types of environmental pollution, their sources, impacts, and preventive measures. • Explore causes of environmental degradation and methods of conservation with special emphasis on Indian biodiversity. • Create awareness about climate change, global warming, environmental legislation, and significant environmental movements in India.			
Module-1		6 Hours	
Ecology: Basic concepts of ecosystem. Ecosystems (structure and function)- forest, desert, wetlands, river, oceanic and lake. Biotic and Abiotic components; Food chain; Ecological pyramid.			
Biogeochemical Cycles: Carbon cycle, nitrogen cycle, phosphorus cycle, water cycle			
Sustainability: 17 Sustainable Development Goals (SDG)- history, targets, implementation, capacity development.			
Module-2		6 Hours	
Environmental Pollution: Surface and ground water pollution, noise pollution, soil pollution, air pollution and marine pollution - sources, impacts on living beings, impacts on environment, preventive measures. case-study on marine pollution.			
Water Chemistry: Significance and effect of pH, total dissolved solids and hardness. Case study on impact of fluoride on human health.			
Module-3		6 Hours	
Environmental Degradation: Causes and effects of deforestation, desertification, soil erosion and glacier melting.			
Environmental Conservation: Significance and key features of national parks, wildlife sanctuaries, reserved forest and mangrove forest. Importance of western ghats as biodiversity hotspot (flora and fauna)			
Module-4		6 Hours	
Indian Monsoon and Global Warming			
Climate- Impact on monsoons, significance of El Nino and La Nina on India climate.			

Global warming: causes, greenhouse gases, effects on environment and human health. Causes and effects of acid rain and ozone depletion. Air sampler and its importance in assessing pollutants.

Module-5

6 Hours

Environmental Legislation: Environmental Protection Act 1984: Definition, Significance and key features.

Indian Environmental Movements: Bishnoi Movement, Chipko & Appiko movement.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe the components and functions of ecosystems and explain major biogeochemical cycles and sustainability goals.
CO2	Understand various forms of pollution and environmental degradation, along with their impacts on ecosystems and human health.
CO3	Demonstrate awareness of climate issues, Indian environmental legislation, and the role of community-based movements in environmental protection.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30		Average of Three Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20		Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration should be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

Text books

1. BennyJoseph, “Environmental studies”, 3rded.,TataMcGraw-Hill, 2017.
2. SMPrakash, “Environmental studies”, 3rd ed.,Pristinepublishinghouse, 2018.

Reference Books:-

1. M.AnjiReddy,“Text book of environmental science and Technology”, revised ed., BS publications, 2014.
2. Dr.B.SChauhan,“Environmentalstudies”,1st ed., University of science press, 2008.



B.E. (Electrical and Electronics Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – IV / V			
Course Title:	BIOLOGY FOR ENGINEERS		
Course Code:	BBOE407/507	CIE MARKS	50
(L: T: P) + SL	(2:0:0) + (30 Hours/Sem)	SEE MARKS	50
Credits:	2	EXAM HOURS	2
COURSE LEARNING OBJECTIVES:			
The purpose of the course is to facilitate the learner to:			
- Familiarize the students with the basic biological concepts and their engineering applications. - Enable the students with an understanding of bio design principles to create novel devices and structures. - Provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems. - Motivate the students to develop interdisciplinary vision of biological engineering.			
Module-1		6 Hours	
Introduction to fundamentals of life. Structure and functions of a cell. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, Proteins, Enzymes and Lipids.			
Module-2		6 Hours	
Introduction to applications of biomolecules, Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, Enzymes in biosensors fabrication, food processing, enzymes in biobleaching, Lipids in biodiesel and detergents production.			
Module-3		6 Hours	
Introduction to adaptations of anatomical principles for bioengineering design, Brain as a CPU system. Eye as a Camera system. Heart as a pump system. Lungs as purification system. Kidney as a filtration system.			
Module-4		6 Hours	
Introduction to nature inspired biomaterials and mechanisms, Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Artificial blood - haemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).			
Module-5		6 Hours	

Introduction to trends in bioengineering, Tissue engineering, stem cells and their applications, Bioprinting techniques and materials. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Bioconcrete.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Corroborate the concepts of biomimetics for specific requirements.
CO2	Understand the basic biological concepts for relevant industrial applications. adaptation.
CO3	Evaluate the principles of design and development, for exploring engineering knowledge in biological
CO4	Think critically towards exploring innovative biobased solutions for socially relevant problems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30		Average of Three Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20		Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration should be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

Text books

1. Basuchandra's Biology for Engineers, Chandra shekara. B.M, Basavaraju B.C, 2025.
2. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.

Reference Books

1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
2. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W.
3. Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
5. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
6. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
7. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
8. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
9. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha, A C Udayashankar, Lambert Academic Publishing, 2019.

**B.E. (Electrical and Electronics Engineering)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V**

Course Title:	RESEARCH METHODOLOGY AND IPR		
Course Code:	BRMK557	CIE MARKS	50
(L : T : P) + SL	(2:0:0) + (30 Hours/Sem)	SEE MARKS	50
Credits:	2	EXAM HOURS	2

COURSE LEARNING OBJECTIVES:

- Understand the fundamental concepts of research and its various types.
- Apply the principles of literature review, technical reading, attribution, and citation in academic research.
- Demonstrate awareness of ethical practices in engineering research.
- Explain the concepts and significance of Intellectual Property Rights (IPR) in engineering.

Module-1 **6 Hours**

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

Module-2 **6 Hours**

Literature Review and Technical Reading:

Introduction to literature review and technical reading, understanding new and existing knowledge, and techniques for analysis and synthesis of prior art. Overview of bibliographic databases such as Web of Science, Google, and Google Scholar. Effective search strategies and approaches for technical reading. Conceptualizing research through critical and creative reading practices

Attributions and Citations: Importance of giving proper credit through attributions and citations. Functions and attributes of citations, and the role of titles and keywords in enhancing citation impact. Understanding knowledge flow through citations and the practice of citing datasets. Overview of citation styles, along with guidelines for acknowledgments and proper attribution in academic writing

Module-3 **6 Hours**

Introduction To Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India. Major Amendments in IP Laws and Acts in India.

Patents: Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of Patenting

Module-4 **6 Hours**

Process of Patenting: Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained? Do I Need First to File a Patent in India? Patent Related

Forms. Fee Structure

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright.

Module-5

6 Hours

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India.

Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. International Treaties.

Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Comprehend the fundamental principles of research and its various classifications
CO2	Analyze and apply concepts of literature review, technical reading, attribution, and citation in research contexts.
CO3	Demonstrate an understanding of ethical practices in engineering research.
CO4	Interpret and explain the role and significance of Intellectual Property Rights (IPR) in engineering and innovation.
CO5	Under standing the basic principles of design rights

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests (MCQs) each conducted for 30 marks
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2, scaled to 20 marks.

Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (C)	50	18	Question papers having 50 MCQs with each question carrying 01 mark, and Exam duration shall be for 2 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbook

1. Dr. Santosh M Nejakar, Dr. Harish Bendigeri “Research Methodology and Intellectual Property Rights”, ISBN 978-93-5987-928-4, Edition: 2023-24.

Reference Book:

1. David V. Thiel “Research Methods for Engineers” Cambridge University Press, 978-1-107-03488-4 2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-

Weblinks and Video Lectures (e-Resources):

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

- Quizzes • Assignments • Seminars

B.E. (Common to All Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	NSS-National Service Scheme		
Course Code:	BNSK559	CIE MARKS	100
L : T : P:	0:0:2:30	SEE MARKS	0
Credits:	0	EXAM HOURS	-
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Identify the needs and problems of the community and involve the problem-solving. 2. Develop among them a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems. 3. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilising community participation to acquire leadership qualities and democratic attitudes.			
Module-1			
Waste management– Public, Private and Govt organization, 5 R's.			
Module-2			
Automation of local Activities			
Module-3			
Organic farming, Indian Agriculture (Past, Present and Future), Connectivity for marketing.			
Module-4			
Spreading public awareness under rural outreach Programs.			
Module-5			
Food preservation and Packaging			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the motto and concepts of NSS
CO2	Develop overall personality of volunteers and make them as leaders and responsible citizens of our nation
CO3	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO4	Communicate effectively with the community and with the officials.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
Evaluation based on Reports (A)	100	-	5 modules Reports, 5 modules X 10 M each = 50 M
Total CIE Theory (A)	100	40	
SEE (B)	-	-	-
CIE+SEE (A+B)	100	40	Final marks shall be the sum of marks scored in Components A, B
- The minimum marks to be secured in CIE is 40 out of allotted 50 marks with minimum 40 % scored in every component of CIE. - No SEE for this subject			

Suggested Learning Resources:

Reference 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.

Web links:

- 1) <https://nss.gov.in/>
- 2) <https://pledge.mygov.in/>

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Physical Education (PE) (Sports and Athletics)		
Course Code:	BPEK559	CIE MARKS	100
L: T: P: S	0:0:2: 0	SEE MARKS	---
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Understand the fundamental concepts of Physical Education, games and sports skills, Health, Nutrition and Fitness - Familiarization of health-related Exercises, Sports for overall growth and development - Participate in the competition at regional/state / national / international levels. - Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.			
Module-1: Title: Athletics - Track Events			3 Hours
110 Mtrs and 400Mtrs: Hurdling Technique: Lead leg Technique, Trail leg Technique Crouch start (its variations) use of Starting Block.			
Module-2: Title: Athletics - Jumps			3 Hours
High Jump A) Approach Run B) Take-off C) Bar Clearance (Straddle) D) Landing			
Module-3: Title: Athletics - Throws			3 Hours
Discuss Throw A) Holding the Discus B) Initial Stance Primary Swing C) Rotation D) Release and Recovery (Rotation in the circle)			
Module-4: Title: Football			3 Hours
A. Fundamental skills - Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick. - Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot. - Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot. - Heading: In standing, running and jumping condition. - Throw-in: Standing throw-in and Running throw-in. - Tackling: Simple Tackling, Slide Tackling.			

7. Goal Keeping: Collection of Ball, Ball clearance- kicking, throwing and deflecting.
 8. Game practice with application of Rules and Regulations
- B. Rules and their interpretation and duties of the officials**

Module-5: Title: Hockey

3 Hours

A. Fundamental skills

1. Passing: Short pass, Long pass , push pass, hit
2. Trapping.
3. Dribbling and Dozing.
4. Penalty stroke practice.
5. Penalty corner practice.
6. Tackling: Simple Tackling, Slide Tackling.
7. Goal Keeping, Ball clearance- kicking, and deflecting.
8. Game practice with application of Rules and Regulations

B. Rules and their interpretation and duties of the officials

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand and demonstrate fundamental techniques of track events including 110m and 400m hurdles, with proper use of starting blocks and hurdling skills.
CO2	Apply technical knowledge of athletic jumps , particularly high jump, including approach run, take-off, bar clearance, and landing techniques.
CO3	Develop skills and perform throwing events , specifically discus throw, with correct techniques such as grip, stance, rotation, release, and recovery.
CO4	Demonstrate fundamental skills of football such as kicking, trapping, dribbling, heading, throw-in, tackling, and goalkeeping along with understanding rules and officiating.
CO5	Exhibit basic skills and techniques in hockey , including passing, trapping, dribbling, tackling, penalty strokes/corners, and understand rules and duties of officials.

ASSESSMENT DETAILS (Both CIE and SEE)

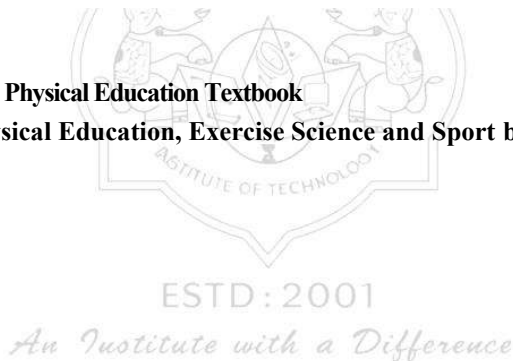
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	---	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	---	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Textbooks:-

1. Health and Physical Education by V.K. Sharma
2. Introduction to Physical Education, Fitness, and Sport by Daryl Siedentop
3. Physical Education Activities, Sports and Games: The Origin and Background, Rules of Play, Teaching Hints and Fundamentals by Louis E. Means

Reference Books: -

1. Saraswati Health and Physical Education Textbook
2. Foundations of Physical Education, Exercise Science and Sport by Deborah A. Wuest



B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Yoga		
Course Code:	BYOK559	CIE MARKS	100
L: T: P: S	0:0:2:0	SEE MARKS	---
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Physical, Mental & spiritual Objectives of Yoga - Explain the meaning of Yoga. - Discuss the importance of the Yoga and its scope. - Describe the aims and objectives of Yoga. - Clarify the misconceptions on Yoga			
Module-1: Title: Suryanamaskara			3 Hours
Suryanamaskar 12 count 6 rounds a) Suryanamaskar prayer. b) Meaning, need & Importance c) Benefits of Suryanamaskara			
Module-2: Title: Yoga			3 Hours
a) Meaning and definition. b) Brief introduction of yogic practices for the common man c) Rules and regulations d) Misconceptions of Yoga			
Module-3: Title: Asanas - Sitting & Standing:			3 Hours
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. Sitting 1. Ardha Ushtrasana 2. Yogamudra in Padmasana Standing 1. Hastapadasana 2. Utkatasana			
Module-4: Title: Asanas - Supine line			3 Hours
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. Supine line 1. Sarvangasana 2. Chakraasana			
Module-5: Title: Pranayama			3 Hours
Kapalabhati - Revision of practice 40 strokes/min - 3 rounds Pranayama -- 1. Ujjayi 2. Sheetal Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama			

VI SEMESTER SUBJECTS

ESTD : 2001
An Institute with a Difference

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Power System Analysis – I		
Course Code:	BEE601	CIE MARKS	50
(L: T: P) + (SL)	(3:0:2) + (45 Hours / Semester)	SEE MARKS	50
Credits:	4	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: - To introduce the per unit system and explain its advantages and computation. - To explain the concept of one line diagram and its implementation in problems. - To explain analysis of three phase symmetrical faults on synchronous machine and simple power systems. - To explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits. - To explain the concept of sequence impedance and its analysis in three phase unbalanced circuits. - To explain the concept of sequence networks and sequence impedances of an unloaded synchronous generator, transformers and transmission lines. - To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components. - To discuss the dynamics of synchronous machine and derive the power angle equation for a synchronous machine. - Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system.			
Module-1			9 Hours
Representation of Power System Components: Introduction, Single-phase Representation of Balanced Three Phase Networks, One-Line Diagram and Impedance or Reactance Diagram, Per Unit (PU) System, Steady State Model of Synchronous Machine, Power Transformer, Transmission of Electrical Power, Representation of Loads.			
Module-2			9 Hours
Symmetrical Fault Analysis: Introduction, Transient on transmission Line, Short Circuit of a Synchronous Machine (On No Load), Short Circuit of a Loaded Synchronous Machine, Illustrative simple examples on power systems. Selection of Circuit Breakers.			
Module-3			9 Hours
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			
Module-4			9 Hours
Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double			

Line-To Ground(LLG)Fault, Open Conductor Faults.	
Module-5	9 Hours
Power System Stability: Introduction, Dynamics of a Synchronous Machine, Review of Power Angle Equation, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion.	

Practical Component of IPCC

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

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Model the power system components & construct per unit impedance diagram of power system.
CO2	Analyze three phase symmetrical faults on power system.
CO3	Compute unbalanced phasors in terms of sequence components and vice versa, also develop sequence networks.
CO4	Analyze various unsymmetrical faults on power system.
CO5	Examine dynamics of synchronous machine and determine the power system

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.

Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.			

SEE for IPCC:

Theory SEE will be conducted as per the scheduled timetable, for the course (duration 03 hours)

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

Books:

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
3. Power System Analysis and Design, J. Duncan Glover et al, Cengage, 4th Edition, 2008.
4. Power System Analysis, Hadi Sadat, McGraw Hill, 1st Edition, 2002.

Web links and Video Lectures (e-Resources):

<https://nptel.ac.in/courses/108104051>

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

Quizzes, Seminars.

B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Signals & Digital Signal Processing		
Course Code:	BEE602	CIE MARKS	50
(L: T: P) + (SL)	(3:2:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	4	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner:</i> • To explain the fundamental signals, their classification and essential signal operations, system properties and analog signal sampling . • Describe the signal convolution in continuous and discrete time domain and the properties of impulse response representation. • Illustrate the computation of Discrete Fourier Transform (DFT) for a sequence using direct method, linear transformation method and Fast Fourier Transform (FFT) algorithms. • Demonstrate the design of IIR analog filters , their conversion to digital filters using impulse invariant and bilinear transformation techniques and realization structures. • Outline the design of FIR filters employing the window method including their realization.			
Module-1		9 Hours	
Introduction to Signals, systems and signal processing, classification of signals, Basic operations on signals, Basic elementary signals, properties of systems. Analog-to-Digital Conversion, sampling of analog signals, sampling theorem, digital to analog conversion. Time-domain representations for LTI systems: Convolution, convolution sum and convolution integral, impulse response representation and its properties, solution of difference equations,Z-transform and ROC basics for LTI systems			
Module-2		9 Hours	
Discrete Fourier Transforms (DFT): Discrete Fourier Transform (DFT) and its inverse, Properties of DFT- linearity, circular time shift, circular frequency shift, circular folding, DFT of complex conjugate sequence, multiplication of two DFTs- the circular convolution, Parseval's theorem			
Module-3		9 Hours	
Fast-Fourier-Transform (FFT) algorithms: Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms), speed improvement factor, Radix-r FFT, Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and decimation-in-frequency algorithms			
Module-4		9 Hours	
Analog Filters: Characteristics of commonly used analog filters–Butterworth and			

Chebyshev Type-I filters, Design of analog filters, frequency transformation in the analog domain.

Digital Filters: Analog to digital transformations: Impulse invariance technique, Bilinear Transformation. Design of digital IIR Filters using Impulse Invariance and Bilinear Transformation representation of IIR filters using direct form I and II, series and parallel forms.

Module-5

9 Hours

FIR Filters: Introduction to FIR filters, symmetric and antisymmetric FIR filters, design of linear phase FIR filters using - Rectangular, Hamming, Hanning and Blackman windows.

Realization of FIR filters: Direct form, linear phase form, cascade form and lattice form structures.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Analyse the classification and basic operations applicable to continuous-time and discrete-time signals, and comprehend the sampling theorem.
CO2	Compute the Discrete Fourier Transform (DFT) of a sequence and understand DFT properties.
CO3	Implement the Fast Fourier Transform (FFT) algorithms.
CO4	Develop Butterworth and Chebyshev IIR digital filters, and represent IIR filters using various structures.
CO5	Synthesize FIR filters using the window method and realize FIR filters.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be

			given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be before 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books :

1. Introduction to Digital Signal Processing, Jhonny R. Jhonson, Pearson 1 st Edition, 2016.
2. Digital Signal Processing – Principles, Algorithms, and Applications, Jhon G. Proakis Dimitris G. Manolakis, Pearson, 4 th Edition, 2007.
3. Digital Signal Processing, A. Nagoor Kani, McGraw Hill, 2nd Edition, 2012.

Reference Books:

1. Digital Signal Processing, Shaila D. Apte, Wiley, 2nd Edition, 2009.
2. Digital Signal Processing, Ashok Amberdar, Cengage, 1st Edition, 2007
3. Digital Signal Processing, Tarun Kumar Rawat, Oxford, 1st Edition, 2015.

Web links and Video Lectures (e-Resources):

1. <http://www.freebookcentre.net/Electronics/DSP-Books>
2. <https://www.electronicsforu.com/special/cool-stuff-misc/8-free-digital-signal-processing-ebooks>

MOOCs

<https://nptel.ac.in/courses/117102060>

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Digital System Design using Verilog		
Course Code:	BEE613A	CIE MARKS	50
(L :T : P) + (SL)	(3:0:0) + (45 Hours/Semester)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> • Learn different Verilog HDL constructs. • Familiarize the different levels of abstraction in Verilog. • Understand Verilog Tasks and Functions. • Understand Timing and Delay Simulation			
Module-1		9 Hours	
Overview of Digital Design with Verilog HDL: Evolution of Computer-Aided Digital Design (CAD), Emergence of HDLs, Typical Design flow, Importance of HDLs, Popularity of Verilog HDL, Trends in HDLs. Hierarchical Modelling Concepts: Design Methodologies, Top-down and Bottom-up design methodology, Modules, Instances, Components of a Simulation, Design Block, Stimulus Block (Test Bench) with example.			
Module-2		9 Hours	
Basic Concepts: Lexical Conventions, Data Types, System Tasks, Compiler Directives. Modules and Ports: Modules, Ports, Connecting Ports, Hierarchical Name			
Module-3		9 Hours	
Gate-Level Modelling: Gate Types-Modeling using basic Verilog gate primitives, Description of AND/OR and BUF/NOT type gates. Gate Delays-Rise, Fall and Turn-Off Delays, Min, Max and Typical Delay Dataflow Modelling: Continuous assignments, Delay Specification, Expressions, Operators, Operands, Operator Types, Examples			
Module-4		9 Hours	
Behavioral Description: Structured Procedures, Initial and Always statements, Procedural Assignments Blocking and Non-Blocking statements, Conditional statements, Multiway Branching, Loops, Sequential and Parallel blocks, Examples-4-to-1 Multiplexer, 4-bit Counter.			
Module-5:		9 Hours	
Structural Description: Highlights of Structural Descriptions, Organization of Structural Description, Binding Tasks and Functions: Differences between Tasks and Functions, Declaration and Invocation Examples			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the Verilog HDL design flow
CO2	Describe the basic concepts of Verilog HDL programming
CO3	Write Verilog programs in Gate, Dataflow, Behavioral, and structural modeling levels
CO4	Write the programs more effectively using Verilog Tasks and Functions.
CO5	Perform Timing and Delay Simulation

ASSESSMENT DETAILS (Both CIE and SEE)

3 -Credit Theory Courses

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Question Paper for SEE

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

- The question paper will have 10 questions with a choice between every pair of questions set for each module. Each question is set for 20 Marks.
- There will be 2 questions from each module. Each of the 2 questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored by the student shall be proportionately scaled down to 50 Marks

Suggested Learning Resources:

Text Books

1. “Verilog HDL: A Guide to Digital Design and Synthesis”, Samir Palnitkar, Pearson education, Second edition.
2. “HDL programming (VHDL and Verilog)”, Nazeih M Botros, John Wiley India Pvt. Ltd., 2. 2008

Reference Books

1. Donald E. Thomas, Philip R. Moorby, “The Verilog Hardware Description Language”, Springer Science + Business Media, LLC, Fifth edition.
2. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL” Pearson (Prentice Hall), Second edition.
3. Padmanabhan, Tripura Sundari, “Design through Verilog HDL”, Wiley, 2016 or earlier

B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Fundamentals Of Electric and Hybrid Vehicle		
Course Code:	BEE613B	CIE MARKS	50
(L :T : P)+SL	(3:0:0)+ 45 Hours/Semester	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> • To understand the origin of electric vehicles and hybrid electric vehicles. • To study about the need of energy storage systems. • To understand the charging and starting systems in electric vehicles. • To understand the concept of hybrid vehicles and its configurations • To study advancement in electric vehicles and technologies.			
Module-1		9 Hours	
Electric Vehicles: History of Modern Transportation, Importance of Different Transportation Development Strategies to Future Oil Supply, Introduction to Electric Vehicles, History of hybrid and electric vehicles, Social, environmental importance and key challenges of hybrid and electric vehicles. Electric Vehicle Technology – layouts, cables, components, Controls.			
Module-2		9 Hours	
Energy storage and Battery Technologies: Introduction to Energy Storage system, Battery Requirements for HEVs, PHEVs, and EVs, Types of batteries, Properties of batteries, working principle and construction of lead-acid, nickel cadmium, nickel metal hydride, lithium-ion batteries, Fuel cell – Introduction, Technologies & Types, Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency			
Module-3		9 Hours	
Charging and Starting System: Requirements of the charging system, charging system principles, Alternators and charging circuits, Diagnosing charging system faults, Advanced charging system technology, New developments in charging systems, requirements of the starting system, Starter motors and circuits, types of starter motor, Diagnosing starting system faults.			
Module-4		9 Hours	
Hybrid Electric Vehicles: Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.			
Module-5:		9 Hours	
Emerging Technologies: Electric Vehicle Supply Equipment, Smart vehicles in smart grid – Vehicle-to-grid technologies: Unidirectional and Bidirectional, Need of Charging Station Selection (CSS) server, Smart grid technologies: Applications / Benefits.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the importance of Electric Transportation system.
CO2	Illustrate the working principle of batteries for EV and HEV system.
CO3	Understand the concept of charging and starting of EV.
CO4	Explain the different configurations of hybrid electric vehicles.
CO5	Interpret the emerging technologies in EV and HEV system.

ASSESSMENT DETAILS (Both CIE and SEE)

3 -Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Text Books:

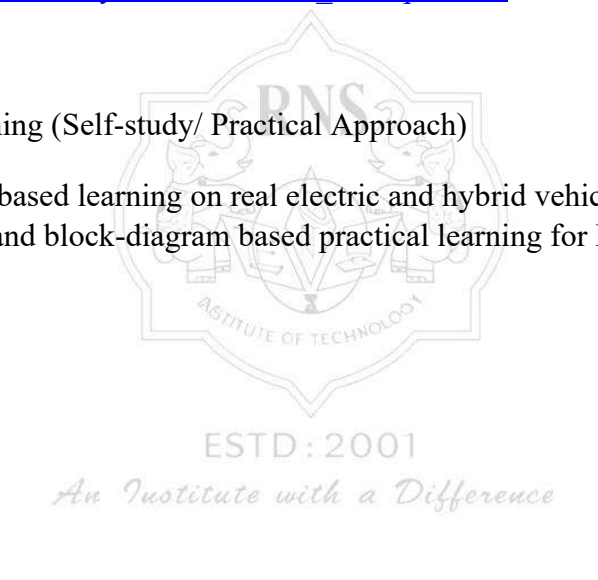
1. M. Ehsani, Y. Gao, and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design" Second Edition, CRC Press, ISBN: 978-1-4200-5398-2, Aug. 2009.
2. Tom Denton, "Automobile Electrical and Electronic Systems" Elsevier Butterworth-Heinemann, Third edition, 2004.
3. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.

Web resources :

1. https://onlinecourses.swayam2.ac.in/ntr26_ed83/preview
2. https://onlinecourses.swayam2.ac.in/ntr26_ed15/preview

Activity based learning (Self-study/ Practical Approach)

- Case study-based learning on real electric and hybrid vehicles.
- Simulation and block-diagram based practical learning for EV systems.



B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VI			
Course Title:	Advanced Control Systems		
Course Code:	BEE613C	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner : 1. To introduce state-space modelling of linear time-invariant continuous-time and discrete-time control systems. 2. To develop and solve state-space models using vector and matrix algebra techniques. 3. To explain and analyze controllability and observability of linear systems. 4. To design state-feedback controllers and state observers using pole-placement methods. 5. To analyze nonlinear control systems using describing function and Lyapunov stability methods.			
Module-1			9 Hours
Review of State Model, State Models for Linear Continuous–Time Systems, State space representation using physical variables			
State space representation: State space representation using phase variables, transfer function, canonical variables, State Variables and Linear Discrete– Time Systems.			
Module-2			9 Hours
State Variable Analysis and Design (continued): Conversion of state variable models to transfer function , Conversion of transfer functions into canaonical state variables models, Eigen values and Eigen vectors, Diagonalization, Properties of state transition matrix, Computation of state transition matrix by Laplace method an Cayley Hamilton Technique, Concepts of Controllability and Observability-Kalman’s Test and Gillbert’s Test.			
Module-3			9 Hours
Pole Placement Design and State Observers: Introduction, Determination of state feedback gain matrix-Transformation Matrix method, Direct Substitution Method, Ackermann’s Method Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design, Design of State Observer, Compensator Design by the Separation Principle.			
Module-4			9 Hours
Non-linear systems Analysis: Introduction, Properties of nonlinear systems, Common Nonlinearities in Control Systems, Fundamentals, Describing Functions of Common Nonlinearities, Stability Analysis by Describing Function Method, Concept of enclosure, Concept of Phase Plane Analysis, Construction of Phase Portraits by Isocline method, Delta method, System Analysis on the Phase Plane.			
Module-5			9 Hours
Non-linear systems Analysis (continued): Concept of stability, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems, Construction of Lyapunov’s Functions for nonlinear systems by Krasovskii’s			

Method.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Apply the state-space approach to model linear time-invariant continuous-time and discrete-time control systems.
CO2	Develop and solve state-space equations of dynamic systems using vector and
CO3	Analyze the controllability and observability properties of linear control systems
CO4	Design state-feedback controllers and state observers using pole-placement techniques to achieve desired system performance.
CO5	Analyze nonlinear control systems using describing function techniques and evaluate system stability using Lyapunov methods.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20		Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books

1. Control Systems Engineering, I. J. Nagarath and M.Gopal, New Age, 5th Edition, 2007.
2. Digital Control and State Variable Methods: Conventional and Intelligent Control Systems, M.Gopal, Mc GrawHill, 3rd Edition, 2008.
3. Modern Control Theory, R. V. Parvatikar, Prism Books Pvt. Ltd, 1st Edition, 2014.



B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VI			
Course Title:	Battery Technology and Battery Management		
Course Code:	BEE613D	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
Course objectives - To introduce the classification and working of automotive lead-acid batteries. - To understand advanced battery and energy storage technologies for transportation applications. - To study battery testing, performance evaluation, and maintenance methods. - To learn battery pack design and Battery Management System concepts for EVs and HEVs. - To gain insight into future automotive batteries, modeling, and environmental aspects.			
Module-1			9 Hours
Introduction to Electrochemical Energy Storage Introduction to battery technology- Electromotive force- Reversible cells- Relation between electrical energy and energy content of a cell-Free energy changes and electromotive force in cell- Current challenges in Energy storage Technologies.			
Module-2			9 Hours
Major Battery Chemistries Development and Testing Battery performance evaluation- Primary battery - Service time- Voltage data – Service life – ohmic load curve – Effect of operating temperature on service life. Secondary batteries – Discharge curves – Terminal voltages- Plateau voltage – Lead acid Batteries – Construction and application.			
Module-3			9 Hours
Battery Charging Introduction, Constant Potential charging – shallow cycle CP charging, Deep cycle & float CP charging for lead acid batteries, two step cycle voltage. Constant current charging – Charge control and charge monitoring of sealed nickel cadmium batteries, types of CC charging, two step CC charging, CC charger designs for normal rate charging. Controlled rapid charger design for Ni–Cd batteries, transformer type and transformer less charge circuits for Ni-Cd batteries			
Module-4			9 Hours
Battery Management System – Introduction Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging , Advanced batteries : Solid-State Batteries, Lithium Polymer Batteries, Lithium Iron Phosphate Batteries, Sodium-Ion Batteries			

Module-5

9 Hours

Battery Management System Requirements

Battery pack topology, Types of BMS, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of-charge estimation, Cell total energy and cell total power.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the classification and working of automotive batteries, with emphasis on lead-acid battery systems.
CO2	Describe the operating principles and applications of advanced energy storage technologies.
CO3	Analyze battery performance characteristics and testing results under different operating conditions.
CO4	Apply battery pack design concepts and BMS functions for EV and HEV applications.
CO5	Evaluate future battery technologies, modeling approaches, and environmental impacts

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3

			hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

TEXT BOOKS:

1. T. R. Crompton, Battery Reference book Third edition, Newnes - Reed Educational and Professional Publishing Ltd, 2000.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.

REFERENCES:

1. Masataka Wakahara and Osamu Yamamoto, Lithium ion Batteries Fundamental and Performance, Wiley-VCH, Verlag GmbH, 2008.
2. Robert A. Huggins, Advanced Batteries – Materials science aspects, Springer, 2009.
3. Ibrahim Dincer, Halil S. Hamut and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", John Wiley & Sons Ltd., 2016.
4. Albert N. Link, Alan C. O' Connor and Troy J. Scot, Battery technology for Electric vehicles, Routledge, 2015
5. G. Pistoia, J.P. Wiaux, S.P. Wolksy, Used Battery Collection and Recycling, Elsevier, 2001

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – 06			
Course Title:	Utilisation Of Electrical Power		
Course Code:	BEE654A	CIE MARKS	50
(L: T: P) +(SL)	(3:0:0) +(45 Hours / Semester)	SEE MARKS	50
Credits:	3	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: - Understand various electrical utilities like heating, welding, lighting, electrolytic process and electric traction. - Analyze the concepts of various types of heating, welding and electrolytic process. - Apply the laws of illumination and lighting calculation and to solve the illustrative examples for the design of lighting schemes. - Classify various types of lighting schemes, and electric motors for traction and Understand and analyse concepts of hybrid vehicles and energy storage systems			
Module-1		9 Hours	
Heating and welding: Electric Heating, Resistance ovens, Radiant Heating, Induction Heating, High frequency Eddy Current Heating, Dielectric Heating, The Arc Furnace, Heating of Buildings,			
Electric Welding: Types of electric welding, resistance and arc welding, control device and welding equipment, power supply requirements for heating and welding process.			
Module-2		9 Hours	
Refrigeration and - Domestic refrigerator and Air coolers, Air-Conditioner – circuit diagram, types and principle of operation.			
Electrolytic Electrometallurgical Process: Ionization, Faraday’s Laws of Electrolysis, Definitions, Extraction of Metals, Refining of Metals, Electro Deposition. Electrolytic Process: Fundamental principles, extraction, refining of metals, electroplating. Factors affecting electro deposition process, power supply for electrolytic process.			
Module-3		9 Hours	
Illumination: Terminologies of illumination, Laws of illumination, lighting schemes and design procedure for lighting calculation. Factory lighting, flood lighting, street lighting, construction and working of incandescent, fluorescent, vapor, CFL and LED lamps. Introduction to electronic ballasts. Star rating concept of energy efficient utilities.			
Module-4		9 Hours	
Electric Traction: Systems of electric traction- mono rails, metro trains- speed time curves, mechanics of train movement, tractive effort, power and energy output from driving axels, train movement and energy consumption specific energy, factors affecting specific energy consumption.			
Control of Traction Motors: Method of speed control, energy saving by series parallel control. AC series motor, characteristics, regenerative braking, linear induction motor and			

their use. Diesel electric equipment, train lighting system.

Module-5

9 Hours

Motors for Electric traction: Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors (Series Type) are used to drive a Motor Car, Tractive Effort and Horse Power, AC Series Motor, Three Phase Induction Motor. plan, why do some business plan fail? Procedure for setting up an enterprise.

Electric Vehicles: Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving, Energy Consumption.

Hybrid Electric Vehicles: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand and describe the various methods and types of heating, welding and refrigeration.
CO2	Understand and discuss the laws of electrolysis, extraction, refining of metals and electro deposition process.
CO3	Analyse the laws of illumination, different types of lamps, lighting schemes and design of lighting
CO4	Analyze systems of electric traction, speed time curves and mechanics of train movement. Explain the motors used for electric traction, their control & braking and power
CO5	Understand the fundamentals and configuration of electric and hybrid vehicles.

ASSESSMENT DETAILS (Both CIE and SEE)

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.

Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

- Utilization of Electric Power and Electric Traction - J.B.Gupta, S.K Kataria and Sons.
- Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design, Mehrdad Ehsani et al, CRC Press, 1st Edition, 2005.
- A Course in Electrical Power - Chakraborty, Soni Gupta &Bhatnagar, Dhanpat Rai and Sons.

Reference Books:

- Utilization of electric energy - Openshaw Taylor, Orient Longman
- Utilization, Generation and Conservation of Electrical Energy, Sunil S Rao, Khanna Publishers, 1st Edition, 2011.
- Utilization of Electric Power and Electric Traction, G.C. Garg, Khanna Publishers, 9th Edition, 2014.

B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VI			
Course Title:	Solar and Wind Energy		
Course Code:	BEE654B	CIE MARKS	50
L :T : P:	3:0:0 (45 hours / semester)	SEE MARKS	50
Credits:	3	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Understand energy sources, their availability and environmental aspects of non-conventional versus conventional energy. - Explore solar energy, solar radiation measurements, beam and diffuse components and radiation on tilted surfaces. - Acquire knowledge on solar energy collectors, physical systems, energy balance equations and collector efficiency - Study solar energy storage, solar thermal storage systems, solar pond and photo-voltaic applications in agriculture and industry - Study wind energy conversion principles, WECS classification, advantages, disadvantages and components			
Module-1		9 Hours	
An introduction to Energy Sources: Energy sources and their availability, Non-Conventional sources, Advantages of Renewable Energy, Prospects of Renewable Energy Sources. Solar Energy: Solar Radiation and its Measurement : Introduction, Solar Constant, Solar Radiation at the Earth’s Surface, Solar Radiation Geometry, Local Solar Time, Solar Radiation Measurements, Solar Radiation Data, Estimation of Average Solar Radiation, Solar Radiation on Tilted Surfaces.			
Module-2		9 Hours	
Solar Energy Collectors : Introduction, Physical Principles of the Conversion of Solar Radiation into Heat, Flat-Plate Collectors, Transmissivity of Cover System, Energy Balance Equation and Collector Efficiency, Concentrating Collector: Focusing Type and Non Focusing Type, Advantages and Disadvantages of Concentrating Collectors over Flat Plate Type Collectors			
Module-3		9 Hours	
Solar Energy Storage: Introduction, Solar Energy Storage Systems, Solar Pond, Principle of Operation and Description of Non-Convective Solar Pond, Extraction of Thermal energy, Applications of Solar Ponds. Applications of Solar Energy : Introduction, Solar Water Heating, Solar Electric Power Generation: Solar Photo-Voltaic, Agriculture and Industrial Process Heat.			
Module-4		9 Hours	
Wind Energy : Introduction, Basic Principles of Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations, Basic Components of a WECS(Wind Energy Conversion System), Classification of WECS, Advantages and			

Disadvantages of WECS

Module-5

9 Hours

Wind Energy Collectors- Horizontal axis machines and Vertical Axis machines, Analysis of Aerodynamic Forces acting on the Blade, Performance of Wind- Machine, Generating Systems, Energy storage, Applications of Wind Energy

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe environmental aspects of non-conventional energy resources, comparing them with conventional systems including prospects and limitations.
CO2	Explain solar energy measurements including solar radiation on tilted surfaces , flat plate collectors and their concentration types.
CO3	Analyse solar energy storage systems, solar ponds and photo-voltaic applications in agriculture and industrial hot water processes.
CO4	Illustrate principles of wind energy conversion , wind data analysis, WECS classification and hybrid systems.
CO5	Evaluate performance of wind machines , generator systems and wind energy storage

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks

SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books :

1. Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2. Energy Technology, S.Rao and Dr. B.B. Parulekar, Khanna Publication. Solarenergy, Subhas PSukhatme, TataMcGrawHill, 2ndEdition, 1996.

Reference Books:

1. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill, 1996
2. Non-Convention EnergyResources, ShobhNath Singh, Pearson, 2018

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

- Poster presentation on the theme of renewable energy sources
- Industry Visit

B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VI			
Course Title:	Industrial Servo Control Systems		
Course Code:	BEE654C	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: • To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques. • To discuss system analogs and vectors, with a review of differential equations. • To discuss the concept of transfer functions for the representation of differential equations. • To discuss mathematical equations for electric servo motors, both DC and brushless DC servomotors. • To represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams. • To determine the frequency response techniques for proper servo compensation.			
Module-1		9 Hours	
Servos: Introduction, Benefits of Servo Systems, Types of Servos - Evolution of Servo Drives, Classification of Drives, Components of Servos - Hydraulic/Electric Circuit Equations, Actuators- Electric, Actuators-Hydraulic, Amplifiers-Electric, Amplifiers-Hydraulic, Transducers (Feedback).			
Module-2		9 Hours	
Machine Servo Drives: Types of Drives, Feed Drive Performance. Troubleshooting Techniques: Techniques by Drive, Problems: Their Causes and Cures. Machine Feed Drives: Advances in Technology, Parameters for making Application Choices. Application of Industrial Servo Drives: Introduction, Physical System Analogs, Quantities and Vectors, Differential Equations for Physical Systems, Electric Servo Motor Transfer Functions and Time Constants, Transport Lag Transfer Function, Hydraulic Servo Motor Characteristics, General Transfer Characteristics			
Module-3		9 Hours	
Generalized Control Theory: Servo Block Diagrams, Frequency-Response Characteristics and Construction of Approximate (Bode) Frequency Charts, Nichols Charts, Servo Analysis Techniques, Servo Compensation. Indexes of Performance: Definition of Indexes of Performance for Servo Drives, Indexes of Performance			

for Electric and Hydraulic Drives.

Module-4

9 Hours

Performance Criteria: Percent Regulation, Servo System Responses.

Servo Plant Compensation Techniques: Dead-Zone Nonlinearity, Change-in-Gain Nonlinearity, Structural

Resonances, Frequency Selective Feedback, Feed forward Control. Machine Considerations: Machine feed

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

Module-5

9 Hours

Machine Considerations: Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed

Considerations, Drive Ratio Considerations, Drive Thrust/Torque And Friction Considerations, Drive Duty

Cycles.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
CO2	Discuss system analogs, vectors and transfer functions of differential equations.
CO3	Discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
CO4	Represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled

(B)			to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books

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

Reference Books:-

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

B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VI			
Course Title:	Testing, Commissioning and Condition Monitoring of Electrical Equipment		
Course Code:	BEE654D	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
Course objectives ➤ To enable students to understand the specifications and standards of electrical equipment as per BIS, IEC and IEEE standards. ➤ To enable students to understand installation practices and commissioning procedures of transformers, electrical machines and switchgear. ➤ To enable students to understand testing, diagnostic and condition monitoring techniques used for electrical equipment. ➤ To enable students to understand modern monitoring technologies, digital substations and intelligent asset management systems. ➤ To enable students to understand predictive maintenance practices and health assessment techniques for electrical assets, renewable energy systems and EV infrastructure.			
Module-1			9 Hours
Power Transformers and Condition Monitoring: Specifications of power and distribution transformers as per BIS/IEC standards. Installation aspects including site selection, foundation, earthing, cooling systems and general inspection. Commissioning tests such as voltage ratio, winding resistance, insulation resistance, polarization index, oil BDV, relay and tap changer testing. Diagnostic techniques including Dissolved Gas Analysis (DGA), Sweep Frequency Response Analysis (SFRA), thermal imaging, moisture assessment and transformer health indexing.			
Module-2			9 Hours
Synchronous Machines and Generator Diagnostics Specifications of synchronous generators and motors. Installation procedures including alignment, excitation systems, cooling arrangements and control gear. Commissioning tests such as insulation resistance, winding resistance, synchronization and vibration measurements. Performance and diagnostic tests including slip test, sudden short-circuit test, transient parameters, sequence impedance measurement, thermal monitoring, vibration analysis, partial discharge monitoring and bearing assessment.			
Module-3			9 Hours
Induction Motors and Predictive Maintenance Specifications of induction motors, duty ratings, efficiency classes and IP protection. Installation involving alignment, coupling, cable termination and earthing. Commissioning tests including insulation resistance, high-voltage, no-load, load, vibration and bearing tests. Diagnostic techniques such as Motor Current Signature Analysis (MCSA), vibration			

analysis, thermal monitoring, bearing fault diagnosis and condition-based maintenance.

Module-4

9 Hours

Switchgear, Protection and Digital Substations

Specifications of circuit breakers, CTs, PTs, relays and associated equipment. Installation aspects including control wiring, earthing and relay coordination. Commissioning tests such as contact resistance, insulation resistance, timing tests, relay testing and CT/PT verification. Introduction to Intelligent Electronic Devices (IEDs), IEC 61850, digital substations, SCADA and remote monitoring.

Module-5

9 Hours

Renewable Energy Systems, EV Infrastructure and Asset Management

Specifications of solar PV systems, inverters, battery energy storage systems and EV charging stations. Installation and grid interconnection requirements. Commissioning tests for PV systems, inverters, batteries and EV chargers. Asset monitoring techniques including IoT-based diagnostics, equipment health indexing, predictive maintenance, reliability assessment and lifecycle management.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the specifications, standards and installation requirements of various electrical equipment.
CO2	Conduct commissioning tests on transformers, synchronous machines, induction motors and switchgear.
CO3	Evaluate the condition and operational performance of electrical equipment using diagnostic and monitoring techniques.
CO4	Interpret the results of advanced diagnostic tests for fault identification and equipment health assessment.
CO5	Apply modern condition monitoring, predictive maintenance and asset management practices in electrical power systems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books

1. W. H. Tang and Q. H. Wu, Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence, Springer, 2021.
2. Alexander Apostolov, IEC 61850: Digitizing the Electric Power Grid, Artech House, 2023.
3. Peter Bishop and Nirmal Kumar C. Nair (Eds.), IEC 61850 Principles and Applications to Electric Power Systems, 2nd Edition, Springer, 2023

Reference Books

1. Relevant BIS, IEC 60076, IEC 61850 and IEEE Standards.
2. Fei Tao and Ang Liu, Digital Twin Driven Smart Manufacturing, Academic Press, 2023.
3. Ahmed Abu-Siada, Application of Smart Condition Monitoring for Power Transformers, IET Publications, 2021.
4. Yubo Yuan and Yi Yang, IEC 61850-Based Smart Substations: Principles, Testing, Operation and Maintenance, Academic Press, 2019.
5. Utility Asset Management and Predictive Maintenance Guidelines, IEEE Press, 2022.

Web resources :NPTEL: Condition Monitoring and Assessment of Power Equipment Taught by Prof. N. P. Padhy & Prof. Premalata Jena, IIT Roorkee
https://onlinecourses.nptel.ac.in/noc24_ee148/preview

Activity based learning (Self-study/ Practical Approach)

1. Analysis of transformer diagnostic reports using DGA and thermal imaging data.
2. Study of condition monitoring and fault diagnosis techniques for electrical machines.
3. Investigation of digital substations and IEC 61850-based communication systems.
4. Assessment of predictive maintenance techniques using vibration and online monitoring data.

Case study on asset management practices in renewable energy systems and EV charging infrastructure.

B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VI			
Course Title:	Signals & Digital Signal Processing Laboratory		
Course Code:	BEEL606	CIE MARKS	50
L :T : P:	(0:0:2)	SEE MARKS	50
Credits:	1	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the student:</i> - To explain the use of MATLAB software in evaluating the DFT and IDFT of given sequence - To verify the convolution property of the DFT - To design and implementation of IIR and FIR filters for given frequency specifications. - To realize IIR and FIR filters. - To help the students in developing DSP software skills			
Sl.No	Experiment		
1	Verification of Sampling Theorem in time and frequency domains		
2	Generation of different signals in both continuous and discrete time domains		
3	To perform basic operations on given sequences- Signal folding, evaluation of even and odd Signals		
4	Evaluation of impulse response of a system.		
5	Solution of a difference equation.		
6	Evaluation of linear convolution and circular convolution of given sequences		
7	Computation of N- point DFT and IDFT of a given sequence by use of (a) Defining equation; (b) FFT method		
8	Evaluation of circular convolution of two sequences using DFT and IDFT approach.		
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters).		
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions.		
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.		
12	Realization of IIR and FIR filters.		
13	Following experiments to be done using DSP Kit: a)Obtain the linear convolution of two sequences b)Compare circular convolution of two sequences c)To find N –point DFT of given sequence d)To find impulse response of first and second order system e)Generation of sine wave and standard test signals		

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain physical interpretation of sampling theorem in time and frequency domains
CO2	Evaluate the impulse response of a system and provide a solution for a given difference equation
CO3	Perform convolution of given sequences to evaluate the response of a system.
CO4	Compute DFT and IDFT of a given sequence using the basic definition and/or fast methods
CO5	Design and implement IIR and FIR filters
CO6	Analyze and simulate DSP systems using software/tools

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C .
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VI			
Course Title:	Simulation and Control of Power Electronics Circuits Lab		
Course Code:	BEEL657	CIE MARKS	50
(L :T : P) + SL	(0:0:2) + (0 hrs/semester)	SEE MARKS	50
Credits:	1	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Simulate any DC-DC converter and observe the performance under various test conditions ➤ Simulate single phase and three phase DC –AC converters and observe the performance under various test conditions ➤ To be able to simulate uncontrolled, half controlled and fully controlled AC-DC converters and observe the performance under various test conditions			

Exp No	TITLE
1	(a)Simulate a single phase half wave diode rectifier. (b)Simulate a single phase full wave diode bridge rectifier.
2	(a) Simulate a single phase half controlled half wave rectifier. (b) Simulate a single phase fully controlled full wave rectifier.
3	Simulate a buck converter with 20 V DC input, and regulate the output at 10 V by implementing a PI controller for closed loop operation. The output power to vary from 10 W to 20 W. Ensure that voltage ripple is limited to 1%.
4	Simulate a boost converter with 20 V DC input, and regulate the output at 35 V by implementing a PI controller for closed loop operation. The output power to vary from 30W to 60 W. Ensure that voltage ripple is limited to 1%
5	Simulate a single phase AC voltage controller using a triac.
6	Simulate a three phase inverter with 180-degree conduction mode for a star connected balanced resistive load. Use IGBT for inverter.
7	Simulate a single phase SPWM inverter with modulation indices of 0.5, 0.6 and 0.8. Use power Mosfets for inverter.
8	Simulate a three phase inverter with 120-degree mode of conduction for a three phase star connected balanced resistive load.
	Demonstration Experiments (For CIE)
9	In expt. 8. connect suitable LC filter at the output to obtain a sinusoidal output with THD of less than 8 %.
10	Simulate a three phase SPWM inverter with modulation indices of 0.5, 0.6 for a star connected load. Use power Mosfets for inverter.
11	Simulate a three phase, 5 level, neutral point clamped (NPC) inverter. The inverter output is connected to a balanced 3 phase resistive load.
12	Simulate a forward converter. Take transformer ratio of 1.5:1. Observe the output voltages for duty cycles of 0.4 and 0.8. Ensure that the output voltage ripple is less than 0.5 V.

COURSE OUTCOMES

CO1	Understand and analyse the working and performance of single phase uncontrolled rectifiers.
CO2	Analyse the working and performance of single phase controlled rectifiers
CO3	Verify the performance of DC-DC converters
CO4	Analyse the working and performance of three phase controlled rectifiers
CO5	Verify the performance of Inverters

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Indian Knowledge Systems		
Course Code:	BIKS608	CIE MARKS	100
(L :T : P) + SL	(1:0:0) + (15 hrs/semester)	SEE MARKS	-
Credits:	1	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is</i> - To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system. - To make the students understand the traditional knowledge and analyze it and apply it to their day-to-day life.			
Module-1		5 Hours	
Introduction to Indian Knowledge Systems (IKS): Overview, Importance of ancient knowledge, The IKS corpus, Vedic Corpus, Philosophical systems, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.			
Module-2		5 Hours	
Fundamental concepts for science and technology: Linguistics, Numbers and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.			
Module-3		5 Hours	
Traditional Knowledge in Professional Domain: Town planning and architecture, Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and Public administration.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Provide an overview of the concept of the Indian Knowledge System and its
CO2	Appreciate the need for 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.

ASSESSMENT DETAILS (CIE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	40	--	Each test will be conducted for 25 Marks adding upto 50 marks. Final test marks will be reduced to 40 Marks
Experimental Learning (B)	40	---	Case Study-based Teaching-Learning. Video-based Seminar (4-5 minutes per student on a relevant IKS topic)
Quiz(C)	20	---	Each quiz is evaluated for 10 marks adding up to 20 Marks.
Total CIE (A+B+C)	100	40	CIE Evaluation is done for a maximum of 100 marks

Suggested Learning Resources:

Text Book:

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- 91818-21-0M. M. Mano, Digital Logic and Computer Design. PHI Learning, 2008. ISBN: 978-81-203-0417-84.

Reference Books:

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

Suggested Web Links:

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003/>
<http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63>
3. (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4. https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5. https://unctad.org/system/files/official-document/ditcted10_en.pdf
6. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8glVTen3Ch27LAmPEAAAYASAAEgIm1vD_BwE



B.E. (Common to All Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	NSS-National Service Scheme		
Course Code:	BNSK659	CIE MARKS	100
L : T : P:	0:0:0:30	SEE MARKS	0
Credits:	0	EXAM HOURS	-
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Identify the needs and problems of the community and involve the problem-solving. - Develop among them a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems. - Develop competence required for group-living and sharing of responsibilities & gain skills in mobilising community participation to acquire leadership qualities and democratic attitudes.			
Module-1			
Contribution to national-level initiatives of the Government of India, such as Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharat, Make in India, the Mudra Scheme, and other skill development programs.			
Module-2			
Spreading public awareness through rural outreach programs. (minimum 5 programs).			
Module-3			
Innovative approaches to assist in the marketing of rural produce			
Module-4			
Creating awareness on rainwater harvesting in Urban areas.			
Module-5			
Creating awareness on digital payment frauds to locals.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Identify and analyze community needs and actively participate in solving social issues through NSS activities.
CO2	Demonstrate social and civic responsibility by engaging in national initiatives and rural outreach programs.
CO3	Develop leadership qualities, teamwork skills, and the ability to mobilize community participation effectively.
CO4	Apply innovative approaches to address real-world problems such as rural development, environmental sustainability, and digital awareness.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
Evaluation based on Reports (A)	100	-	5 modules Reports, 5 modules X 10 M each = 50 M
Total CIE Theory (A)	100	40	
SEE (B)	-	-	-
CIE+SEE (A+B)	100	40	Final marks shall be the sum of marks scored in Components A, B
- The minimum marks to be secured in CIE is 40 out of allotted 50 marks with minimum 40 % scored in every component of CIE. - No SEE for this subject			

Suggested Learning Resources:

Reference Books:

- 4) NSS Course Manual, Published by NSS Cell, VTU Belagavi.
- 5) Government of Karnataka, NSS cell, activities reports and its manual.
- 6) Government of India, NSS cell, Activities reports and its manual.

Web links:

- 3) <https://nss.gov.in/>
- 4) <https://pledge.mygov.in/>

B.E. (Electrical & Electronics Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VI			
Course Title:	Physical Education (PE) (Sports and Athletics)		
Course Code:	BPEK659	CIE MARKS	100
L: T: P: S	0:0:2: 0	SEE MARKS	---
Credits:	---	EXAM HOURS	2 Hrs
COURSE LEARNING OBJECTIVES:			
The purpose of the course is to facilitate the learner to:			
- Understand the fundamental concepts of Physical Education, games and sports skills, Health, Nutrition and Fitness - Familiarization of health-related Exercises, Sports for overall growth and development - Participate in the competition at regional/state / national / international levels. - Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.			
Module-1: Title: Athletics - Track Events - Relays			3 Hours
Relays			
Relay Race: Starting, Baton Holding/Carrying, Baton Exchange in between zone, and Finishing			
Module-2: Title: Athletics - Triple Jumps			3 Hours
Triple Jump			
E) Approach Run			
F) Take-off			
G) Step,			
H) Flight in the Hop			
I) Jump and Landing			
Module-3: Title: Athletics - Throws			3 Hours
Javelin Throw			
E) Grip			
F) Carry and Recovery (3/5 Impulse stride).			
G) Release			
Module-4: Title: CRICKET			3 Hours
A. Fundamental skills			
1. Batting - Forward Defense Stroke, Backward Defense Stroke, Off Drive, On			
2. Drive, Straight Drive, Cover Drive, Square Cut.			
3. Bowling -Out-swing, In-swing, Off Break, Leg Break and Googly.			
4. Fielding: Catching - The High Catch, The Skim Catch, The Close Catch and throwing at the stumps from different angles. Long Barrier and Throw, Short Throw, Long Throw, Throwing on the Turn.			
5. Wicket Keeping			
B. Rules and their interpretation and duties of the officials			
Module-5: Title: BASEBALL			3 Hours

C. Fundamental skills

1. Player Stances – walking, extending walking, L stance, cat stance
2. Grip – standard grip, choke grip
3. Batting – swing and bunt. Pitching
4. Baseball: slider, fast pitch, curve ball, drop ball, rise ball, change up, knuckle ball, screw ball,

D. Rules and their interpretation and duties of the officials

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Demonstrate the techniques of relay races , including starting, baton holding, exchange within the zone, and finishing, along with basic skills of javelin
CO2	Apply the fundamental techniques of triple jump , including approach run, take-off, hop, step, jump, flight, and landing.
CO3	Develop and perform javelin throw techniques , including grip, carry, impulse stride, release, and recovery with proper coordination.
CO4	Exhibit fundamental skills of cricket , including batting, bowling, fielding, wicket keeping, and understand rules and duties of officials.
CO5	Demonstrate basic skills and techniques in baseball , including player stances, grip, batting, pitching, and understand rules and officiating.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	---	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	---	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Textbooks:-

1. Health and Physical Education by V.K. Sharma
2. Introduction to Physical Education, Fitness, and Sport by Daryl Siedentop
3. Physical Education Activities, Sports and Games: The Origin and Background, Rules of Play, Teaching Hints and Fundamentals by Louis E. Means

Reference Books: -

1. Saraswati Health and Physical Education Textbook
2. Foundations of Physical Education, Exercise Science and Sport by Deborah A. Wuest



B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Yoga		
Course Code:	BYOK659	CIE MARKS	100
L: T: P: S	0:0:2:0	SEE MARKS	---
Credits:	---	EXAM HOURS	2 Hrs
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Physical, Mental & spiritual Objectives of Yoga - Explain the meaning of Yoga. - Discuss the importance of the Yoga and its scope. - Describe the aims and objectives of Yoga. - Clarify the misconceptions on Yoga			
Module-1: Title: Suryanamaskara			3 Hours
Suryanamaskara - Revision of practice 12 count 8 rounds d) Suryanamaskar prayer. e) Meaning, need & Importance f) Benefits of Suryanamaskara			
Module-2: Title: Asanas			3 Hours
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. Sitting: 1. Bakasana 2. Hanumanasana 3. Yogamudra in Vajrasana Standing: 1. Vatayanasana 2. Garudasana			
Module-3: Title: Asanas			3 Hours
Need, importance of Asana. Different types, Asana by name, technique, precautionary measures and benefits of each asana Prone line 1. Bhujangasana 2. Shalabh asana Supine line 1. Utthita dvipadasana, 2. Ardha halasana Balancing 1. Sheershasana			
Module-4: Title: Pranayama			3 Hours
Kapalabhati - Revision of Kapalabhati practice 80 strokes/min 3 rounds			

Module-5: Title: Pranayama	3 Hours
Pranayam 1. Bhastrika 2. Bhramari Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the meaning, objectives, scope, and importance of Yoga, including its physical, mental, and spiritual benefits and misconceptions.
CO2	Demonstrate Suryanamaskara (12 counts, 8 rounds) with correct technique, prayer, and understanding of its need and benefits.
CO3	Perform sitting and standing Asanas (Bakasana, Hanumanasana, Yogamudra in Vajrasana, Vatayanasana, Garudasana) with proper technique, precautions,
CO4	Execute prone, supine, and balancing Asanas (Bhujangasana, Shalabhasana, Utthita Dvipadasana, Ardha Halasana, Sheershasana) with correct body
CO5	Practice Pranayama techniques (Kapalabhati, Bhastrika, Bhramari) with proper method, breathing control, and understanding of their importance and health benefits.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	----	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	----	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Suggested Learning Resources:

Textbooks

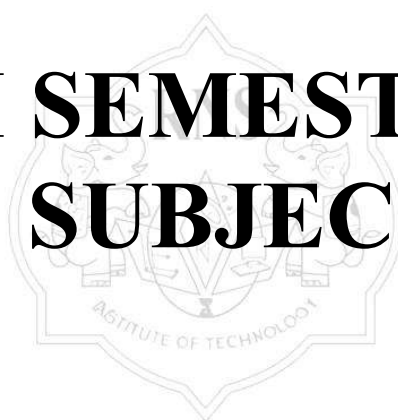
1. The Yoga Sutras of Patanjali – Sri Swami Satchidananda.
2. Light on Yoga — B.K.S Iyengar.

Reference Books: -

1. The Heart of Yoga — T.K.V Desikachar.
2. Asana Pranayama Mudra Bandha by Swami Satyananda Saraswati.



VII SEMESTER SUBJECTS



ESTD : 2001

An Institute with a Difference

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title	Power System Protection		
Course Code	BEE701	CIE Marks	50
(L:T:P) + (SL)	(3:0:2) + (45 Hours / Semester)	SEE Marks	50
Credits	04	Exam Hours	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to</i> - Understand the fundamentals of power system protection, fault analysis, protection zones, instrument transformers, and protective schemes used in electrical power systems. - Acquire knowledge of the operating principles, characteristics, and applications of electromechanical, static, numerical, and intelligent protective relays used in modern protection systems. - Understand the phenomena of arc interruption and the operation, selection, and application of conventional and advanced circuit breakers employed in power system protection. - Analyze and apply protection schemes for generators, transformers, motors, and busbars to ensure reliable and secure operation of power system equipment. - Explore transmission line protection techniques and emerging trends such as IEC 61850-based protection systems, wide-area monitoring, and AI-based motor fault diagnosis and protection.			
MODULE – 1			9 Hours
Fundamentals of Power System Protection: Introduction to Power System Protection, Need for Protective Scheme, Causes and types of Faults, Zones of Protection, Essential Qualities of Protective Relays, Protection System Components, Primary and Backup Protection, Instrument Transformers (CTs and PTs)			
MODULE – 2			9 Hours
Protective Relays: Relay operating principle, construction and characteristics Electromechanical Relays: Overcurrent relay, Directional relay, Differential relay, Distance relay Static Relays: Introduction, functional block diagram, advantages and limitations Numerical Relays: Introduction, Digital relay Architecture, Advantages, Digital relay algorithm, IEC61850 fundamentals			
MODULE – 3			9 Hours
Circuit Breaker: Fundamentals of Circuit Breaking, Arc Characteristics, Current Interruption Restriking Voltage, Recovery Voltage, Rate of Rise of Recovery Voltage (RRRV), Current Chopping, Resistance Switching Types of Circuit Breakers: Oil Circuit Breaker, Air-Blast Circuit Breaker, SF ₆ Circuit Breaker, Vacuum Circuit Breaker, Intelligent Digital Circuit Breaker, Hybrid Circuit Breaker			

MODULE – 4	9 Hours
Generator Protection: Stator Fault Protection Rotor Fault Protection, Differential Protection Transformer Protection: Percentage Differential Protection, Buchholz Relay, Harmonic restraint relay Motor Protection: Overload Protection, Earth Fault Protection, Thermal Protection Busbar Protection: Differential Protection	
MODULE – 5	9 Hours
Transmission Line Protection: Overcurrent Protection, Distance Protection: Distance Relaying Impedance Relay, Reactance Relay, Mho Relay, Characteristics and Applications Carrier Current Protection, Pilot Protection Application of AI in Motor Fault classification and Protection: Introduction to Artificial Intelligence Techniques: Practical Application of AI Systems in Induction motor fault classification & protection (Block diagram)	

PRACTICAL COMPONENT OF IPCC

Experiments :

1. Over Current Relay: Inverse Definite Minimum Time (IDMT) Non – Directional Characteristics.
2. IDMT Characteristics of Electromechanical type over voltage Relay. Electromechanical type).
3. Operation of Negative Sequence Relay.
4. Operating Characteristics of Microprocessor Based (Numeric) Over – Current Relay.
5. Operating Characteristics of Microprocessor Based (Numeric) Under Voltage Relay.
6. Feeder Protection against Faults.
7. Motor Protection against Faults.
8. Fuse Characteristics.
9. Measurement of Breakdown Strength of Transformer Oil.
10. Field Mapping using Electrolytic Tank for cable and transmission Line.

Simulation Experiments:

1. Circuit Breaker status indication from field input (Virtual lab)
2. Fault scenario simulation in a Transformer / Bus (Virtual lab)

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Analyze power system faults and protection requirements using protection zones, relay characteristics, and instrument transformers.
CO2	Compare and evaluate electromechanical, static, numerical, and intelligent relays used in modern power system protection
CO3	Evaluate the operation and suitability of various circuit breakers for fault interruption under different power system conditions.
CO4	Design appropriate protection schemes for generators, transformers, motors, and busbars.
CO5	Analyze transmission line protection methods and apply AI-based techniques in intelligent motor fault diagnosis and protection.

ASSESSMENT DETAILS (Both CIE and SEE)

Continuous Internal Evaluation (CIE) :

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.

CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only.			

SEE for IPCC:

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

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

Suggested Learning Resources:

Text Books

1. Power System Protection and Switchgear Badri Ram, D.N. Vishwakarma McGraw Hill 2nd Edition
2. Power System Protection and Switchgear Bhuvanesh Oza et al McGraw Hill 1st Edition, 2010
3. A Text Book on Power System Engineering, M.L. Soni, P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 2nd edition, 1998, Dhanpat Rai & Co. ISBN-13 : 978-8177000207.

Reference Books

1. Protection and Switchgear Bhavesh et al Oxford 1st Edition, 2011
2. Power System Switchgear and Protection N. Veerappan S.R. Krishnamurthy S. Chand 1st Edition, 2009
3. Fundamentals of Power System Protection Y.G.Paithankar S.R. Bhide PHI 1st Edition, 2009
4. Various Faults Classification of Industrial Application of Induction Motors Using Supervised Machine Learning: A Comprehensive Review, 19 August 2025, IEEE Access (Volume:13), Page(s): 146649 – 146675, DOI: 10.1109/ACCESS.2025.3600570 is available at <https://ieeexplore.ieee.org/document/11129626>
5. Power system relaying, Staley H.Horowitz & Arun G. Padke, 3rd Edition, 2008, John Wiley & Sons Inc., ISBN: 978-0-470-75878-6.
6. NPTEL notes on numerical relays and algorithms
7. IEC 61850 based substation automation system, A survey “International Journal of Electrical Power Energy Systems, Vol.120, Article 106008,2020. DOI:10.1016/j.ijepes.2020.106008. is available at <https://www.sciencedirect.com/science/article/abs/pii/S0142061520304646>

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title	Power System Analysis - II		
Course Code	BEE702	CIE Marks	50
(L:T:P) + (SL)	(3:0:2) + (45 Hours / Semester)	SEE Marks	50
Credits	04	Exam Hours	03
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner - To explain formulation of network models and bus admittance matrix for solving load flow problems. - To discuss optimal operation of generators on a bus bar and optimum generation scheduling. - To explain symmetrical fault analysis and algorithm for short circuit studies. - To explain formulation of bus impedance matrix for the use in short circuit studies on power systems. - To explain numerical solution of swing equation for multi-machine stability. - To develop admittance and impedance matrices of interconnected power systems. - To explain the use of suitable standard software package. - To solve power flow problem for simple power systems. - To perform fault studies for simple radial power systems. - To study optimal generation scheduling problems for thermal power plants			
MODULE – 1			9 Hours
Network Topology: Introduction and basic definitions of Elementary graph theory Tree, cut-set, loop. Formation of Incidence Matrices. Primitive network-Impedance form and admittance form, Formation of Y Bus by Singular Transformation. Y bus by Inspection Method. Illustrative examples.			
MODULE – 2			9 Hours
Load Flow Studies: Introduction, Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidel iterative method. Illustrative examples.			
MODULE – 3			9 Hours
Load Flow Studies(continued): Newton-Raphson method derivation in Polar form, Fast decoupled load flow method, Flow charts of LF methods. Comparison of Load Flow Methods. Illustrative examples			
MODULE – 4			9 Hours
Economic Operation of Power System: Introduction and Performance curves Economic generation Scheduling neglecting losses and generator limits Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses Derivation of transmission loss formula. Illustrative examples.			
Unit Commitment: Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flow chart and Algorithm only)			
MODULE – 5			9 Hours

Symmetrical Fault Analysis: Z Bus Formulation by Step by step building algorithm without mutual Coupling between the elements by addition of link and addition of branch. Illustrative examples. Z bus Algorithm for Short Circuit Studies excluding numerical.

Power System Stability: Numerical Solution of Swing Equation by Point by Point method and Runge Kutta Method. Illustrative examples

Text Books

1. Power System Protection and Switchgear Badri Ram, D.N. Vishwakarma McGraw Hill 2nd Edition
2. Power System Protection and Switchgear Bhuvanesh Oza et al McGraw Hill 1st Edition, 2010

Reference Books

1. Protection and Switchgear Bhavesh et al Oxford 1st Edition, 2011
2. Power System Switchgear and Protection N. Veerappan S.R. Krishnamurthy S. Chand 1st Edition, 2009
3. Fundamentals of Power System Protection Y.G. Paithankar S.R. Bhide PHI 1st Edition, 2009

Practical Component of IPCC

Sl.No	Experiments
1	To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines. (Using suitable simulation package.)
2	Y-Bus Formation for Power Systems with and without Mutual Coupling, by Singular Transformation
3	Y-Bus Formation for Power Systems without Mutual Coupling, by Inspection method
4	Formation of Z-Bus (without mutual coupling) using Z-Bus Building Algorithm.
5	Formation of Jacobian matrix in Polar Coordinates, for a System having less than 4 Buses.
6	Determination of Bus Currents, Bus Power and Line Flows, for a Specified System Voltage.
7	Load Flow Analysis using Gauss Siedal Method for the system with both PQ buses and PV Buses. By simulation.
8	Load Flow Analysis using NR Method and Fast Decoupled Method for the

	system with both PQ buses and PV Buses. (Using suitable simulation package.)
9	Write a program to generate unit commitment schedule for a system with three units using priority listing method (priority based on least cost).
10	Optimal Generation Scheduling for Thermal power plants (Using suitable simulation package.)

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Formulate network matrices and models for solving load flow problems.
CO2	Perform steady state power flow analysis of power systems using numerical iterative techniques.
CO3	Solve issues of economic load dispatch and unit commitment problems.
CO4	Analyze short circuit faults in power system networks using bus impedance matrix.
CO5	Apply Point by Point method and Runge Kutta method to solve Swing Equation.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.			

SEE for IPCC:

Theory SEE will be conducted as per the scheduled timetable, for the course (duration 03 hours)

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

Books:

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
3. Power System Analysis and Design, J. Duncan Glover et al, Cengage, 4th Edition, 2008.
4. Power System Analysis, Hadi Sadat, McGraw Hill, 1st Edition, 2002.

Web links and Video Lectures (e-Resources):

<https://nptel.ac.in/courses/108102047>

<https://nptel.ac.in/courses/108105067>

<https://nptel.ac.in/courses/108104051>

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

Quizzes, Seminars.

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Industrial Drives and Applications		
Course Code:	BEE703	CIE MARKS	50
(L:T:P) + (SL)	(3:2:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: • To define electric drive, its parts, advantages and explain choice of electric drive. • To explain dynamics and modes of operation of electric drives. • To explain control of DC motor using rectifiers. • To analyze the performance of induction motor drives under different conditions. • To explain the control of synchronous motor • To explain, stepper motor drives., SRM and other special machines and discuss typical applications electrical drives in the industry and automation			
MODULE – 1			9 Hours
Electric Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives Dynamics of Electrical Drives: Fundamental Torque Equations, Speed Torque Conventions and Multi-quadrant Operation. Equivalent values of Drive parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization. Control Electrical Drives: Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives. Phase locked Loop control (PLL)			
MODULE –2			9 Hours
Direct Current Motor Drives: Controlled Rectifier Fed DC Drives, Single Phase Fully Controlled Rectifier Control of DC Separately Excited Motor, Single Phase Half Controlled Rectifier Control of DC Separately Excited Motor, Multi-quadrant Operation of DC Separately Excited Motor Fed From Fully Controlled Rectifier, Rectifier Control of DC Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited DC Motor, Chopper Control of Series Motor.			
MODULE-3			9 Hours
Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources. Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source inverter (CSI) Control, Comparison of VSI and CSI, current regulated voltage source inverter control, speed control of single phase induction motors.			
MODULE-4			9 Hours
Synchronous Motor Drives: Operation from fixed frequency supply-starting, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thyristor inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives,			

Sinusoidal PMAC Motor Drives, Brushless DC Motor Drives.	
MODULE-5	9 Hours
Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor.	
Switched Reluctance Motor Drives: Construction and operation, Torque and power capabilities, closed loop speed control.	
Solar powered Drives: Solar powered pump drives, solar powered Electric vehicles.	
Industrial Application and Automation: Electric Drives in Industrial automation, applications.	
Industrial Drives: Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools, use of single to three phase semiconductor converters in rural applications.	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the advantages, choice and control of electric drive
CO2	Explain the dynamics, generating and motoring modes of operation of electric drives
CO3	Analyze the performance & control of DC motor drives and AC motor drives using controlled rectifiers.
CO4	Explain working of special machines in industrial automation.
CO5	Explain the application of drives in industry and in rural areas.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment type	Maximum Marks	Minimum passing marks	Evaluation details
CIE-IA Tests(A)	30	-	Average of three Internal assessment. Tests each of 50 marks, scaled down to 20 marks
Alternate assessment (B)	20	-	Two assignments covering complete syllabus or assessment methods as per 24RNBE4.2 scaled to 20 marks
Total CIE (A+B)	50	20	CIE is done for a maximum of 50 marks
SEE (C)	50	18	SEE is the theory exam conducted for 100 marks and scaled down to 50 marks
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in components A,B,C

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Suggested Learning Resources:

Text Books

1. [Gopal K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing, 2nd Edition, 2001](#)
2. [Vedum Subrahmanyam, "Electrical Drives: Concepts and for Industrial Drives", McGraw Hill, 2nd Edition, 2011](#)

Reference Books

1. [N. K De, P.K. Sen, "Electric Drives", PHI Learning , 1st Edition, 2009](#)



B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Power System Planning		
Course Code:	BEE714A	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner : - To introduce and explain the principles, processes, organisational structure, and forecasting methods used in power system planning at national and regional levels. - To develop understanding of techno-economic evaluation, financial analysis, tariff structures, and generation expansion planning. - To introduce advanced generation expansion concepts and explain transmission planning criteria, network studies, and energy storage. - To explain distribution planning principles, deregulation aspects, and reliability and quality standards in power systems. - To introduce demand-side management concepts and explain electricity market structures and operational mechanisms.			
Module-1			9 Hours
Power System: Power Systems, Planning Principles, Planning Process, Project Planning, Power Development, Power Growth, National and Regional Planning, Enterprise Resources Planning, Structure of a Power System, Power Resources, Planning Tools, Power Planning Organisation, Regulation, Scenario Planning. Electricity Forecasting: Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System			
Module-2			9 Hours
Power-System Economics: Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation Units, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment, Optimum Investment, Tariffs. Generation Expansion: Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies.			
Module-3			9 Hours
Generation Expansion (continued): Distributed Power Generation, Renovation and Modernisation of Power Plants. Transmission Planning: Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage			
Module-4			9 Hours

Distribution: Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity, Upgradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification, Villages Self – Sufficiency in Energy, Community Power, Self – Generation.

Reliability and Quality: Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Reliability Target, Security Requirement, Disaster Management, Quality of Supply, Reliability and Quality Roadmap.

Module-5

9 Hours

Demand-Side Planning: Demand Response, Demand – Response Programmes, Demand–Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit.

Electricity Market: Market Principles, Power Pool, Independent System Operator, Distribution System Operator, Power Balancing, Market Participants, Power Markets, Market Rules, Bidding, Trading, Settlement System, Locational Marginal Pricing, Transmission Charges, Merchant Power, Differential Electricity, Congestion Management, Ancillary Services, Hedging, Smart Power Market.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain power system planning concepts and apply electricity load forecasting techniques to estimate system load and peak demand.
CO2	Analyze economic characteristics of generation systems and evaluate optimal generation expansion strategies.
CO3	Analyze transmission network requirements and apply planning criteria for
CO4	Evaluate distribution system reliability and quality indices and assess planning strategies for secure and resilient power supply.
CO5	Assess demand response programmes and evaluate electricity market operations including pricing, trading, and congestion management.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.

Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books:

1. Electric Power Planning A. S. Pabla McGraw Hill, 2nd Edition, 2016

.Web resources : https://onlinecourses.nptel.ac.in/noc26_ee35/preview

Activity based learning (Self-study/ Practical Approach)

- Case study–based analysis of power system planning and electricity forecasting using real utility data. Simulation / self-study exercise on power system economics, demand response, and electricity market operations.

B.E. (Electrical & Electronics Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VII			
Course Title:	High Voltage Engineering		
Course Code:	BEE714B	CIE MARKS	50
L : T : P:	3:0:0 (45 hours / semester)	SEE MARKS	50
Credits:	3	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Understand the fundamentals of high voltage technology, including breakdown mechanisms in gases, liquids, and solids - Analyze methods for generating high AC, DC, and impulse voltages using laboratory equipment. - Evaluate techniques for precise measurement of high voltages and currents. - Apply insulation testing and non-destructive techniques for electrical apparatus evaluation. - Recognize industrial applications and safety aspects of high voltage engineering.			
Module-1			9 Hours
INTRODUCTION: Introduction to HV technology, need for generating high voltages in laboratory. Industrial applications of high voltage, Gaseous dielectrics, Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory breakdown in non uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen's law and its significance. Time lags of Breakdown. Breakdown in solid dielectrics: Intrinsic Breakdown, avalanche breakdown, thermal breakdown, and electro mechanic breakdown. Breakdown of liquid dielectrics: Suspended particle theory, electronic Breakdown, cavity breakdown (bubble's theory), electro convection breakdown.			
Module-2			9 Hours
GENERATION OF HV AC AND DC VOLTAGE: HV AC-HV transformer; Need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. HV DC- voltage doubler circuit, cock croft- Walton type high voltage DC set. Calculation of high voltage regulation, ripple and optimum number of stages for minimum voltage drop			
Module-3			9 Hours
GENERATION OF IMPULSE VOLTAGE AND CURRENT: Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for Output impulse voltage. Multistage impulse generator working of Marx impulse. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage. Generation of high impulse current.			
Module-4			9 Hours
MEASUREMENT OF HIGH VOLTAGES: Electrostatic voltmeter-principle,			

construction and limitation. Chubb and Fortescue method for HV AC measurement. Generating voltmeter- Principle, construction. Series resistance micro ammeter for HV DC measurements. Standard sphere gap measurements of HV AC, HV DC, and impulse voltages; Factors affecting the measurements. Potential dividers-resistance dividers capacitance dividers mixed RC potential dividers. Measurement of high impulse currents-Rogowski coil and Magnetic Links.

Module-5

9 Hours

NON-DESTRUCTIVE INSULATION TESTING TECHNIQUES: Dielectric loss and loss angle measurements using Schering Bridge, Transformer ratio Arms Bridge. Need for discharge detection and PD measurements aspects. Factor affecting the discharge detection. Discharge detection methods-straight and balanced methods.

HIGH VOLTAGE TESTS ON ELECTRICAL APPARATUS: Definitions of terminologies, tests on isolators, circuit breakers, cables insulators and transformers.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain breakdown processes and insulation properties in various dielectrics
CO2	Design and analyse high voltage generation circuits like cascade transformers and Marx generators
CO3	Measure high voltages using voltmeters, dividers, and sphere gaps accurately
CO4	Perform high voltage tests on apparatus such as transformers and circuit breakers
CO5	Assess partial discharge detection and non-destructive testing methods for insulation

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ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.

Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

• The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.

Suggested Learning Resources:

Text Books :

1. High Voltage Engineering, M.S.Naidu and Kamaraju- 4th Edition, THM, 2008.
2. High Voltage Engineering Fundamentals, E.Kuffel and W.S. Zaengl, 2nd Edition, Elsevier Press, 2005.
3. High Voltage Engineering ,C.L.Wadhwa, New Age International Private limited, 1995.

Reference Books:

- 1.High Voltage Engineering Theory and Practice, Mazen Abdel-Salam, Hussein Anis, AhdabElMorshedy, RoshdyRadwan, 2nd Edn(Revised & Expanded) Marcel-Dekker Publishers(Special Indian Edn.).

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

- Industry Visit

B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	ENERGY AUDIT & ENERGY MANAGEMENT SYSTEM		
Course Code:	BEE714C	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner : - To understand the concepts of energy audit, energy management, and energy efficiency techniques. - To study about electric motors, DG sets, pumps, and lighting systems with respect to energy performance. - To provide insights into energy conservation techniques and system optimization strategies. - To understand financial analysis methods for evaluating energy-saving projects			
Module-1			9 Hours
Introduction: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, instruments Optimizing the input energy requirements, Fuel and energy substitution, Energy audit.			
Module-2			9 Hours
Electric Motors: Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors.			
Module-3			9 Hours
DG Set System: Introduction, Factors affecting selection, Operational Factors, Energy performance assessment of diesel conservation avenues. Pumps and Pumping System: Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities, Energy performance assessment on pumps.			
Module-4			9 Hours
Lighting Systems: Introduction, Basics terms in lighting, Types of lamps and features, Methodology of Lighting System Energy Efficiency Study, Case studies, Energy performance assessment on lighting.			
Module-5			9 Hours
Financial Analysis: Introduction, Fixed and variable cost, Interest charges, Simple payback period, Discounted cash flow methods, Case studies.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the concepts of energy audit, types, need, and energy management principles.
CO2	Understand the electric motors performance in industrial application and identify the energy saving opportunities.
CO3	Assess the performance of DG sets and Pumps.
CO4	Explain the lighting system and energy saving methods.
CO5	Evaluate the financial analysis for energy projects and recommend solutions.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books:

1. Murphy, W.R. , Mckay, G. (1982) 'Energy Management ', London: Butterworth-Heinemann
2. K. Smith, C.B. (Ed. 4) (1981). 'Energy Management Principles : applications, benefits, savings', Amsterdam : Pergamon Press.

Web resources :

1. [Preview: Basic Principles of Energy Management & Energy Audit | SWAYAM](#)
2. [BUREAU OF ENERGY EFFICIENCY, Government of India, Ministry of Power](#)

Activity based learning (Self-study/ Practical Approach)

- Case study–based learning for residential energy consumption and savings.
Prepare a audit report for lighting energy in an indoor stadium.



B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Smart Grid		
Course Code:	BEE714D	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner : - To understand smart grid concepts and architecture - To Analyze Smart Grid Communication and Measurement Systems - To Apply Performance Analysis Tools in Smart Grid Design - To Implement Communication Technology and Cybersecurity for Smart Grids - To Integrate Automation and Distributed Energy Resources			
Module-1			9 Hours
Smart Grid Architectural Designs: Introduction, evolution of electric Grid, conventional power systems and smart grid, definition of smart grid, need for smart grid, smart grid architecture, smart grid domains, enablers of smart grid, communication architecture and protocols for smart grid, smart grid priority standards and regulation, smart-grid activities in India.			
Module-2			9 Hours
Technologies for Smart Grid Communication and Measurement: Communication and Measurement, Monitoring, PMU, Smart Meters and Measurements Technologies ,Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU), Smart Meters , Smart Appliances, Advanced Metering Infrastructure (AMI), GIS and Google Mapping Tools Multi agent Systems (MAS) Technology ,Multi agent Systems for Smart Grid Implementation , Micro grid and Smart Grid Comparison			
Module-3			9 Hours
Performance Evaluation Tools for Smart Grid Design: Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods ,types ,Load Flow State of the Art: Classical, Extended Formulations, and Algorithms , Congestion Management Effect , Load Flow for Smart Grid Design , Cases for the Development of Stochastic Dynamic optimal Power Flow (DSOPF), Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingency Studies for the Smart Grid			
Module-4			9 Hours
Communication and Cybersecurity Technologies for Smart Grid Operations: Data communication, switching techniques, communication channels,HAN,NAN,WAN, Bluetooth, Zigbee, GPS, Wi-Fibased communication, Wireless mesh network, Basic of cloud computing and cyber security for smart grid, Broadband over power line			
Module-5			9 Hours
Control, Automation and EV Integration for Smart Grids: Transmission infrastructure, technology, Energy Management System (EMS), Map Board, Automatic Generation Control (AGC), Supervisory Control, SCADA Master Terminal Unit, Transmission Substations, Phasor			

Measurement Units (PMUs) as IEDs, Relays, PLCs, RTUs, Smart Transmission Cyber Security. Distribution system architecture, Importance of the Distribution System and Its Security Challenges, Distribution Management Systems (DMS), standards, interoperability, and cyber security.

Vehicle-to-grid (V2G) and Grid to Vehicle (GV2) concept, Impact of EVs integration on Distribution Networks, Demand Management with EVs Distribution system architecture, Importance of the Distribution System and Its Security Challenges, Distribution Management Systems (DMS), standards, interoperability, and cyber security.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe the transition from conventional grids to smart grids, including architecture, domains, standards, regulations, and Indian initiatives.
CO2	Evaluate communication, measurement, and monitoring technologies such as PMUs, smart meters, AMI, MAS, and microgrids in smart grids.
CO3	Analyze smart grid performance using load flow methods, DSOPF, and security
CO4	Examine data communication systems, cloud platforms, and cybersecurity measures for reliable smart grid operations.
CO5	Apply control, automation, SCADA/EMS, and EV integration techniques to improve grid efficiency, reliability, and demand response

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks

SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Textbooks

1. Smart Grid 3.0: Computational and Communication Technologies – Bhargav Appasani & Nicu Bizon (2023)
2. Handbook of Smart Energy Systems – Michel Fathi, Enrico Zio, Panos M. Pardalos (2023)
3. Smart Grids — Renewable Energy, Power Electronics, Signal Processing and Communication Systems Applications – Alfeu J. Sguarezi Filho, Rogério V. Jacomini, Carlos E. Capovilla, Ivan Roberto Santana Casella (2023)
4. Fundamentals of Smart Grid Systems – Muhammad Kamran (2023)
5. Data Science and Applications for Modern Power Systems – Le Xie, Yang Weng, Ram Rajagopal (2023)
6. Power Line Communication Systems for Smart Grids (2nd Edition) – Ivan R.S. Casella, Alagan Anpalagan (2024/25)

Reference Books

1. Modern Power System Analysis – D. P. Kothari & I. J. Nagrath: 5th edition published in 2022. McGraw Hill India
2. Distributed Generation and its Implications for Smart Grids – F. Katiraei, M. R. Iravani: I could not locate a publication year for this exact title; I found a related book (“Handbook of Distributed Generation”) published in 2017.
3. Advanced Metering Infrastructure (AMI) and Smart Metering Technologies – R. Faranda & S. Leva:

Web resources :

https://onlinecourses.nptel.ac.in/noc24_ee148/preview?utm_source=chatgpt.com

Taught by Prof. N. P. Padhy & Prof. Premalata Jena (IIT Roorkee)

Activity based learning (Self-study/ Practical Approach)

- Design a conceptual smart grid for a campus including generation, distribution, smart meters, and EV charging.
- Analyze smart meter load data to identify peak demand and propose demand response strategies.

Design a microgrid with solar/wind and storage for a residential area.



B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Fundamentals of Electric Vehicle		
Course Code:	BEE755A	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner : • To understand the concept of electric vehicles. • To study about the motors & drives for electric vehicles. • To understand the electronics and sensors in electric vehicles. • To understand the concept of hybrid vehicles. • To study about fuel cell for electric vehicles.			
Module-1		9 Hours	
Introduction to Electric Vehicles : Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.			
Module-2		9 Hours	
Electric Vehicle Motors: Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Converter, Design.			
Module-3		9 Hours	
Electronics and Sensor-less control in EV: Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self drive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.			
Module-4		9 Hours	
Hybrid Vehicles: Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.			
Module-5		9 Hours	
Fuel Cells for Electric vehicles: Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe about working principle of electric vehicles.
CO2	Explain the construction and working principle of various motors used in electric vehicles
CO3	Understand about working principle of electronics and sensor less control in
CO4	Describe the different types and working principle of hybrid vehicles.
CO5	Illustrate the various types and working principle of fuel cells.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20		Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Text Books:

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

Web resources :

1. https://onlinecourses.swayam2.ac.in/ntr26_ed83/preview
2. https://onlinecourses.swayam2.ac.in/ntr26_ed15/preview

Activity based learning (Self-study/ Practical Approach)

- Case study–based learning on real electric and hybrid vehicles.

Simulation and block-diagram based practical learning for EV systems.

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	ENERGY CONSERVATION AND AUDIT		
Course Code:	BEE755B	CIE MARKS	50
(L: T: P) +(SL)	(3:0:0) +(45 Hours / Semester)	SEE MARKS	50
Credits:	3	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: 1. Understand the current energy scenario and importance of energy conservation. 2. Understand the methods of improving energy efficiency in different electrical systems. 3. Understand and Realize energy auditing process. 4. Explain about various pillars of electricity market design. 5. To explain the scope of demand side management, its concept and implementation issues and strategies.			
Module-1			9 Hours
Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change.			
Module-2			9 Hours
Energy conservation: Introduction, motivation for Energy conservation, principles of Energy conservation, Energy outages – Issues and Remedy, Protection and Safety, Mitigating energy losses. Energy Efficiency in Electrical Systems: Electrical load management and maximum demand Control, Maximum demand controllers Power factor improvement, Automatic power factor controllers, efficient operation of transformers, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Energy efficient lighting and measures of energy efficiency in lighting system.			
Module-3			9 Hours
Energy auditing: Introduction, Aim of Energy Audit, Energy flow diagram, Energy management team, Elements of energy audits, different types of audit, Considerations in implementing Energy conservation programs, Periodic progress review for optimization of energy use. Energy use profiles, measurements in energy audits, presentation of energy audit results.			
Module-4			9 Hours
Electricity and other Commodities: Distinguishing features of electricity as a commodity, Four pillars of market design: Imbalance, Scheduling and Dispatch, Congestion Management, Ancillary Services. Tariff: Objectives, Types of Tariff, Electricity billing Calculations, Framework of Indian power sector and introduction to the availability-based tariff (ABT).			
Module-5			9 Hours

Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.

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

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Analyse about energy scenario and outline energy conservation and its features.
CO2	Understand load management techniques and energy efficiency in Electrical Systems.
CO3	Understand the need of energy audit and apply energy audit methodology.
CO4	Understand the various commodities and evaluate electricity billing systems.
CO5	Show an understanding of demand side management and energy conservation.

ASSESSMENT DETAILS (Both CIE and SEE)

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.

CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

1. Generation of Electrical Energy: B.R.Gupta, Chand & Company, 5th Edition
2. Energy Management: Umesh Rathore, S.K.Kataria & Sons, 2nd edition, 2004
3. Energy Management Handbook, W.C. Turner, John Wiley, and Sons.

Reference Books:

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

B.E. (Electrical and Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	PLC & SCADA		
Course Code:	BEE755C	CIE MARKS	50
(L: T: P) +(SL)	(3:0:0) +(45 Hours / Semester)	SEE MARKS	50
Credits:	3	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i>			
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Module-4	9 Hours
Data Manipulation Instructions: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control. Math Instructions: Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations.	
Module-5	9 Hours
Sequencer and Shift Register Instructions: Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations. Process Control, Network Systems, and SCADA: Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA).	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand PLC history, architecture, hardware, and programming fundamentals.
CO2	Explain field devices used in PLC-based automation systems.
CO3	Analyze PLC ladder logic using timers, counters, and control instructions.
CO4	Apply data handling and closed-loop control concepts in PLC applications.
CO5	Evaluate sequencers, shift registers, process control, and communication systems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks

SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

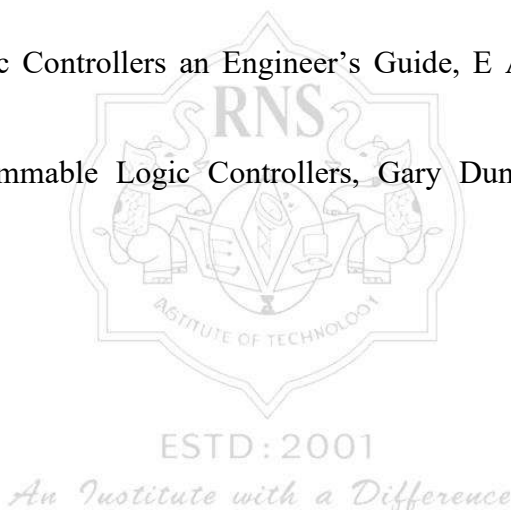
Suggested Learning Resources:

Textbook

1. Programmable Logic Controllers, Frank D Petruzella, McGraw Hill, 4th Edition, 2011.

Reference Books

1. Programmable Logic Controllers an Engineer's Guide, E A Parr, Newnes, 3rd Edition, 2013.
2. Introduction Programmable Logic Controllers, Gary Dunning, Cengage, 3rd Edition, 2006.



B.E. (Electrical & Electronics Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Sensors and Transducers		
Course Code:	BEE755D	CIE MARKS	50
(L:T:P) + (SL)	(3:0:0) + (45 Hours / Semester)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: - To discuss need of transducers, their classification, advantages and disadvantages. - To discuss working of different types of transducers and sensors. - To discuss recent trends in sensor technology and their selection. - To discuss basics of signal conditioning and signal conditioning equipment. - To discuss configuration of Data Acquisition System and data conversion. To discuss the basics of Data transmission and telemetry. - To explain measurement of various non-electrical quantities.			
Module-1			9 Hours
Sensors and Transducers: Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers			
Module-2			9 Hours
Sensors and Transducers (continued): Strain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems.			
Module-3			9 Hours
Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers. Data Acquisition Systems and Conversion: Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.			
Module-4			9 Hours
Data Transmission and Telemetry: Data/Signal Transmission, Telemetry. Measurement of Non – Electrical Quantities: Pressure Measurement			
Module-5			9 Hours
Measurement of Non – Electrical Quantities (continued): Temperature Measurement, Flow Measurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Meters, Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level, Measurement of Viscosity.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the need of transducers, their classification, working of various transducers and sensors.
CO2	Outline the recent trends in sensor technology and their selection.
CO3	Analyze signal conditioning equipment, different configurations of Data Acquisition System and data conversion.
CO4	Illustrate the knowledge of data transmission and telemetry.
CO5	Summarize the measurement of non-electrical quantities using transducers.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum mark to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

Textbook:

1. Electrical and Electronic Measurements and instrumentation, R.K Rajput, S. Chand, 3rd Edition, 2013.

Reference Books:

1. A Course in Electronics and Electrical Measurements and Instruments, J.B. Gupta, Katson Books, 13th Edition, 2008.
2. A Course in Electrical and Electronic Measurements and Instrumentation, A. K. Sawheny, Dhanpat Rai, 2015.





VISION

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