NEW HORIZON
COLLEGE OF ENGINEERING

Department of Electrical and Electronics Engineering

Academic Year 2025-26

7th and 8th Semester Scheme and Syllabus

BATCH - 2022-2026

CREDITS: 160

NEW HORIZON
COLLEGE OF ENGINEERING

Department of Electrical and Electronics Engineering

Academic Year 2025-26

7th and 8th Semester Scheme & Syllabus

BATCH: 2022-26

CREDITS: 160

Contents		
S. No.	**Vision, Mission, POs, PSOs & PEOs**	**P. No.**
1	Institution Vision, Mission, Goals and Quality policy	**3**
2	Department Vision, Mission and Program Educational Objective (PEO)	**4**
3	Program Outcomes (PO) with Graduate Attributes	**5**
4	Program Specific Outcomes (PSOs)	**6**
	Scheme	
5	Scheme of Seventh and Eighth Semester B.E.	**7**
	Syllabus	
6	**Syllabus of Seventh Semester BE:**	**11**
	a) 22EEE71 – Power System Analysis	**12**
	b) 22EEL71 – Power System Analysis Laboratory	**14**
	c) 22EEE72 – Advanced Industrial Automation and Control	**16**
	d) 22EEL72 – Advanced Industrial Automation and Control Laboratory	**19**
	e) 22EEE73 – Photovoltaic Systems and Applications	**21**
	f) 22EEE74 – Project Phase – II	**23**
	g) 23NHOP7XX – Industrial Open Elective Course-II	
7	**Syllabus of Eighth Semester BE:**	**25**
	a) 22EEE81X-Professional Elective Course-III 22EEE811 – Neural Network and Fuzzy Logic in Electrical Engineering 22EEE812 – Machine learning for Electrical Engineering 22EEE813 – Quantum Computing 22EEE814 – Power System Operation and Control 22EEE815 – Power Quality	**26** **29** **31** **33** **35**
	b) 22EEE82X- Professional Elective Course-IV 22EEE821 – FACTS and HVDC transmission 22EEE822 – Testing and Commissioning 22EEE823 – Energy Auditing and Demand Side Management 22EEE824 – Utilization of Electrical Energy 22EEE825 – Smart Grid Technologies	 **37** **40** **42** **44** **46**
	c) 22EEE83 – Internship	**49**
	d) 22IKK84 –Indian Knowledge Systems	**52**
	Appendix A: List of Assessment Patterns	**54**
	Appendix B: Outcome Based Education	**55**
	Appendix C: The Graduate Attributes of NBA	**56**
	Appendix D: Bloom's Taxonomy	**58**

NEW HORIZON COLLEGE OF ENGINEERING

VISION

To emerge as an institute of eminence in the fields of engineering, technology and Management in serving the industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

MISSION

- To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a culture of research and innovation among faculty members and students.
- To encourage long-term interaction between the academia and industry through their involvement in the design of curriculum and its hands-on implementation.
- To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities**.**

QUALITY POLICY

To provide educational services of the highest quality both curricular and co-curricular to enable students integrate skills and serve the industry and society equally well at global level.

VALUES

- Academic freedom
- Integrity
- Inclusiveness
- Innovation
- Professionalism
- Social Responsibility

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To evolve into a centre of excellence in Electrical and Electronics Engineering for bringing out contemporary engineers, innovators, researchers and entrepreneurs for serving nation and society.

MISSION

- To provide suitable forums to enhance the teaching-learning, research and development activities.
- Framing and continuously updating the curriculum to bridge the gap between industry and academia in the contemporary world and serve society.
- To inculcate awareness and responsibility towards the environment and ethical values.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: To provide good learning environment to develop entrepreneurship capabilities in various areas of Electrical and Electronics Engineering with enhanced efficiency, productivity, cost effectiveness and technological empowerment of human resource.

PEO2: To inculcate research capabilities in the areas of Electrical and Electronics Engineering to identify, comprehend and solve problems and adopt themselves to rapidly evolving technology.

PEO 3: To create high standards of moral and ethical values among the graduates to transform them as responsible citizens of the nation.

PEO TO MISSION STATEMENT MAPPING

PEOs	**MISSION OF THE DEPARTMENT**		
	M1	**M2**	**M3**
PEO1	3	3	2
PEO2	3	3	2
PEO3	2	2	3

PROGRAM OUTCOMES (POs)

S. No.	Graduate Attributes	Program Outcomes (POs)
1	Engineering Knowledge	PO1: Able to understand the fundamentals of mathematics, science, Electrical and Electronics Engineering and apply them to the solution of complex engineering problems.
2	Problem Analysis	PO2: Ability to identify, formulate and analyse real time problems in Electrical and Electronics Engineering.
3	Design and Development of Solutions	PO3: Design solutions for complex engineering problems, that meet the specified needs and to interpret the data.
4	Investigation of Problem	PO4: Use research-based knowledge and research methods to provide valid solutions for complex problems in Electrical and Electronics Engineering.
5	Modern Tool usage	PO5: Apply appropriate tools techniques for modeling, analyzing and solving Electrical and Electronics Engineering devices & systems.
6	Engineer and society	PO6: To give basic knowledge of social, economical, safety and cultural issues relevant to professional engineering.
7	Environment and sustainability	PO7: To impart knowledge related to the design and development of modern systems which are environmentally sensitive and to understand the importance of sustainable development.
8	Ethics	PO8: Apply ethical principles and professional responsibilities in engineering practice.
9	Individual & team work	PO9: Ability to visualize and function as an individual and as a member in a team of a multi-disciplinary environment.
10	Communication	PO10: Ability to communicate effectively complex engineering ideas to the engineering community & the society at large.
11	Lifelong learning	PO11: To impart education to learn and to engage in independent and life–long learning in the technological change.
12	Project management and finance	PO12: Ability to handle administrative responsibilities, manage projects & handle finance related issues in a multi-disciplinary environment.

PEOs to POs mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
PEO1	3	3	3	3	3	2	2	2	2	2	2	2	3	3
PEO2	3	3	3	3	3	2	2	2	2	2	2	2	3	3
PEO3	2	2	2	2	2	3	3	3	3	2	2	2	2	2

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Graduates will be able to solve real life problems of power system and power electronics using MiPower, PSPICE and MATLAB software tools and hardware.

PSO 2: Graduates will be able to develop & support systems based on Renewable and Sustainable Energy Sources.

NEW HORIZON COLLEGE OF ENGINEERING

B. E. in Electrical and Electronics Engineering

Scheme of Teaching and Examinations for 2022- 2026 BATCH (2022 Scheme)

VII Semester													
S. No.	Course and Course Code		Course Title	BoS	Credit Distribution				Overall Credits	Contact Hours	Marks		
					L	T	P	S			CIE	SEE	Total
1	PCC	22EEE71	Power System Analysis	EE	3	0	0	0	3	3	50	50	**100**
2	PCCL	22EEL71	Power System Analysis Laboratory	EE	0	0	1	0	1	2	50	50	**100**
3	PCC	22EEE72	Advanced Industrial Automation and Control	EE	3	0	0	0	3	3	50	50	**100**
4	PCCL	22EEL72	Advanced Industrial Automation and Control Laboratory	EE	0	0	1	0	1	2	50	50	**100**
5	PCC	22EEE73	Photovoltaic Systems and Applications	EE	3	0	0	0	3	3	50	50	**100**
6	PROJ	22EEE74	Project Phase - II	EE	0	0	10	0	10	20	100	100	**200**
7	OEC	23NHOP7XX	Industrial Open Elective Course-II	Offering Dept.	3	0	0	0	3	3	50	50	**100**
								Total	**24**	**36**	**400**	**400**	**800**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course, **PROJ**: Project work**, L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Self Study for Skill Development, C**IE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Industrial Open Elective Courses-II:

Credit for OEC is 03 (L: T: P: S) can be considered as (3: 0: 0 : 0). The teaching and learning of these Courses will be based on hands-on. The Course Assessment will be based on CIE and SEE in practical mode. This Courses will be offered by Centre of Excellence to students of all the branches. Registration to Industrial open electives shall be documented and monitored on college level.

Project Phase-II:

The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

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

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

(2)Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25.

Credit Definition: 1-hour Lecture (L) per week=1Credit 2-hoursTutorial(T) per week=1Credit 2-hours Practical / Drawing (P) per week=1Credit 2-hous Self Study for Skill Development (SDA) per week = 1 Credit	03-Credits courses are to be designed for 40 hours in Teaching-Learning Session 02- Credits courses are to be designed for 25 hours of Teaching-Learning Session 01-Credit courses are to be designed for 15 hours of Teaching-Learning Sessions

NEW HORIZON COLLEGE OF ENGINEERING

B. E. in Electrical and Electronics Engineering

Scheme of Teaching and Examinations for 2022- 2026 BATCH (2022 Scheme)

VIII Semester

S. No.	Course and Course Code		Course Title	BoS	Credit Distribution				Overall Credits	Contact Hours	Marks		
					L	T	P	S			CIE	SEE	Total
1	PEC*	22EEE81X	Professional Elective Courses -III	EE	3	0	0	0	3	3	50	50	**100**
2	PEC*	22EEE82X	Professional Elective Courses -IV	EE	3	0	0	0	3	3	50	50	**100**
3	INT	22EEE83	Internship	EE	0	0	10	0	10	20	100	100	**200**
4	NCMC	22IKK84	Indian Knowledge Systems	EE	0	0	0	0	0	1	50	-	**50**
Total									**16**	**27**	**250**	**200**	**450**

PEC*: Professional Elective Course (Online/Hybrid), **L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Self Study for Skill Development, **INT**: Industry Internship / Research Internship / Rural Internship, CIE: Continuous Internal Evaluation, **SEE**:Semester End Evaluation.
NCMC: Online Assessment

Professional Elective Course-III			
22EEE811	Neural Network and Fuzzy Logic in Electrical Engineering	22EEE814	Power System Operation and Control
22EEE812	Machine learning for Electrical Engineering	22EEE815	Power Quality
22EEE813	Quantum Computing		

Professional Elective Course-IV			
22EEE821	FACTS and HVDC transmission	22EEE824	Utilization of Electrical Energy
22EEE822	Testing and Commissioning of Electrical Equipments	22EEE825	Smart Grid Technologies

22EEE823	Energy Auditing and Demand Side Management		

Elucidation:
At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Internship.

Internship: The mandatory Internship is for **14 to 20 weeks**. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent SEE examination after satisfying the internship requirements. For 8th semester students, the following internship options are available:

- Industry Internship
- Research Internship
- Skill Enhancement Courses
- Post-Placement Training as Internship
- Online Internship

Industry internship: It is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints. Students undertaking industry internships must ensure the organization is listed on the VTU Internship Portal. If not, request the organization to register on the portal.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research. Research internships must be carried out in recognized research centers. Ensure that these centers are registered on the portal.

Skill Enhancement Courses: Students can take Skill-based courses with credits totalling the same as those of the internship. Students must be taken from registered providers listed on the VTU Internship Portal.

Post-Placement Training as Internship: The post-placement training is also considered an internship. For students placed during their 6th/7th semester and willing to take the training during their final year, colleges must inform the recruiting companies in advance to register on the VTU Internship Portal.

Online Internship: Reputed online internship platforms, including those identified by NSDC, are already listed on the VTU Internship portal. If colleges come across other eligible organizations not yet listed, they are informed to ask the organization to register on the VTU Internship portal.

Credit Definition: 1-hour Lecture (L) per week=1 Credit 2-hoursTutorial(T) per week=1 Credit 2-hours Practical / Drawing (P) per week=1 Credit	03-Credits courses are to be designed for 40 hours in Teaching-Learning Session 02- Credits courses are to be designed for 25 hours of Teaching-Learning Session 01-Credit courses are to be designed for 15 hours of Teaching-Learning Sessions

2-hous Self Study for Skill Development (SDA) per week = 1 Credit	

Syllabus of Seventh Semester BE

POWER SYSTEM ANALYSIS

Course Code	**22EEE71**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE71.1	Apply the concept of per-unit reactance, bus incidence, Y-bus and Z-bus matrices for modelling the actual power system
22EEE71.2	Evaluate steady state power flow analysis of power system using Gauss-Seidel, Newton-Raphson and fast decoupled iterative methods
22EEE71.3	Analyze symmetrical and unsymmetrical faults in a power system
22EEE71.4	Compare various types of faults by analyzing real time power system applications
22EEE71.5	Analyze steady state and transient stability of power system
22EEE71.6	Design mathematical models for power system using dedicated software tools and thus analyze power system stability

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE71.1	3	3	3	-	2	-	-	-	-	-	-	2	2	2
22EEE71.2	3	3	3	2	3	-	-	-	-	-	-	2	2	2
22EEE71.3	3	2	3	3	2	-	-	-	-	-	-	2	2	2
22EEE71.4	3	3	3	3	2	-	-	-	-	-	-	2	2	2
22EEE71.5	3	3	3	3	2	-	-	-	-	-	-	2	2	2
22EEE71.6	3	3	3	2	3	-	-	-	-	-	-	2	2	2

MODULE-1	**PER-UNIT SYSTEM MODELLING AND NETWORK MATRICES**	**22EEE71.1, 22EEE71.3**	**8 Hours**

Introduction, Single line diagram, per unit system, per unit impedance and reactance diagram of power system Bus Incidence matrix, Formation of Bus Admittance Matrix-Inspection method (Without half line charging admittance), Singular transformation method (with and without mutual coupling), Bus impedance matrix (Building algorithm without mutual coupling)

Self- study	Formation of incidence matrix
Text Book	Text Book 1: 4.1-4.4

MODULE-2	**LOAD FLOW STUDIES AND TECHNIQUES**	**22EEE71.2, 22EEE71.6**	**8 Hours**

Introduction, Power flow equations, Classification of buses, Operating constraints. Gauss-Seidal Method, Acceleration of convergence; Newton Raphson's Method, Fast Decoupled load flow method, Comparison of Load Flow Methods. (Numerical problems for one iteration only)

Self- study	Load flow analysis using FDLF method
Text Book	Text Book 2: 6.1-6.8

MODULE-3	**SYMMETRICAL FAULT ANALYSIS AND COMPONENTS**	**22EEE71.3, 22EEE71.4**	**8 Hours**

Transients on a transmission line, short circuit current and reactance of synchronous machines on no load and on load, Selection of circuit breaker ratings. Analysis of Unbalanced load against Balanced 3 phase supply, resolution of unbalanced phasors into their symmetrical Components-Power in terms of symmetrical components.

Self- study	NA
Text Book	Text Book 2: 9.1-9.5, 10.1-10.9

MODULE-4	**UNSYMMETRICAL FAULTS**	**22EEE71.3, 22EEE71.4**	**8 Hours**

Sequence Networks, sequence impedances and sequence networks of power system elements (alternators, transformers and transmission lines), Positive sequence network, negative sequence network and zero sequence network of power system elements

Conceptual study of L-G, L-L, L-L-G, faults on an unbalanced alternator without and with fault impedance, Unsymmetrical faults on power system, Numerical problems

Self- study	NA

Text Book	Text Book 2: 11.1-11.5		
MODULE-5	**STABILITY ANALYSIS**	**22EEE71.5**	**8 Hours**
Introduction, Dynamics of a synchronous machine-swing equation, power angle equation, steady state and transient stability. Equal area criterion for transient stability evaluation, Factors affecting transient stability, Methods of improving transient stability, Recent trends of improving transient stability.			
Self- study	Methods to improve stability in power system		
Text Book	Text Book 2: 12.1 to 12.8 Text Book 3:11.1-11.5		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	7.5	5
L4	Analyze	5	7.5	5
L5	Evaluate	5	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	15
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Computer Methods in power System Analysis, G. W. Stagg, A. H. El-Abiad, 2019, 2nd edition, Medtech. ISBN:978-9388716154
2) Modern Power System Analysis, I. J. Nagrath, D. P. Kothari, 2005, 3rd edition, Tata McGraw Hill Publications, New Delhi, India. ISBN:978-0-07-049489
3)Power System Analysis, Hadi Saadat, 2010, Revised Edition, PSA Publishers, New Delhi.ISBN:978-0984543809

Reference Books:

1) Computer Techniques in Power System Analysis, M. A. Pai , 2008, 2nd edition, Tata McGraw Hill Publications, New Delhi, India. ISBN:978-9332901131

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc19_ee62/preview
- https://archive.nptel.ac.in/courses/108/107/108107127/

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

- Visit to any substation or industry related to manufacturing of power system components
- Video demonstration of latest trends in Power system
- Economic Dispatch Puzzle
- Organizing Group wise discussions on faults in power system and its causes

POWER SYSTEM ANALYSIS LABORATORY

Course Code	**22EEL71**	**CIE Marks**	**50**
L: T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

22EEL71.1	Compute per-unit reactance diagrams, bus incidence, Y-bus and Z-bus matrices for modelling the actual power system using simulation tool
22EEL71.2	Evaluate power flow analysis using Gauss-Seidel, Newton-Raphson and fast decoupled iterative methods using simulation tools
22EEL71.3	Analyze steady state and transient stability of power system using Simulink
22EEL71.4	Design mathematical models for power system using software tools

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEL71.1	3	3	3	1	3	-	-	-	1	-	-	2	3	3
22EEL71.2	3	3	-	3	3	-	-	-	1	-	-	2	3	3
22EEL71.3	3	3	1	3	3	-	-	-	1	-	-	2	3	3
22EEL71.4	3	3	1	3	3	-	-	-	1	-	-	2	3	3

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	• Basic Knowledge in MATLAB • Load Flow Equations • Bus Formation	2	NA
	PART-A		
1	Computation of Parameters and Modelling of Transmission Lines		22EEL71.1
2	Formation of Bus Admittance Matrices and Solution of Networks. i) By Inspection method ii) By Singular Transformation Method (without Mutual coupling) iii) By Singular Transformation Method (with Mutual coupling)	2	22EEL71.2
3	Determination of bus currents, bus power, line flows and line losses for a specified system profile.	2	22EEL71.2
4	Determination of power angle plot for a) Salient pole synchronous machine b) Non salient pole synchronous machine	2	22EEL71.4
5	Formation of Bus impedance matrix using Building algorithm.	2	22EEL71.1 22EEL71.4
6	Formation of Jacobian for a system not exceeding 4 buses (without PV buses) in polar coordinates.	2	22EEL71.3
	PART-B		
7	Transient stability analysis of SMIB system using swing equation	2	22EEL71.4
8	Short circuit analysis for power system-Using Mi-Power	2	22EEL71.3
9	Load Flow Analysis – I: Solution of load flow and related problems using Gauss-Seidel Method	2	22EEL71.4
10	Load Flow Analysis – II: Solution of load flow and related problems using Newton Raphson.	2	22EEL71.3
11	Load Flow Analysis – III: Solution of load flow and related problems using Fast CO3 Decoupled Method.	2	22EEL71.3
12	Economic Dispatch in Power system-Using Mi-Power	2	22EEL71.3

PART-C

Beyond Syllabus Virtual Lab Content
(To be done during Lab but not to be included for CIE or SEE)

1. Determination of positive, negative and zero sequence components of an alternator- https://vp-dei.vlabs.ac.in/Dreamweaver/
2. Formation of Reactance Diagram https://srmeeevlab.github.io/PSA/loe.html

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	5	5
L3	Apply	5	5
L4	Analyze	5	10
L5	Evaluate	5	10
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	10
L4	Analyze	20
L5	Evaluate	10
L6	Create	-

Suggested Learning Resources:
Reference Books:

1) Modern Power System, D. P. Kothari, 2011 McGraw Hill, 4TH Edition, ISBN:978-0071077750
2) Power System Analysis, Hadi Saadat ,2010, Revised Edition, PSA Publishers, New Delhi.ISBN:978-0984543809

ADVANCED INDUSTRIAL AUTOMATION AND CONTROL			
Course Code	**22EEE72**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE72.1	Understand the architecture, features, and communication protocols of SCADA systems used in industrial automation.
22EEE72.2	Analyze the design, components, and operational efficiency of building management systems and energy management systems.
22EEE72.3	Describe the structure and working of home automation and fire alarm systems, including their safety, security, and communication standards.
22EEE72.4	Apply the principles of PID control and design PLC-based PID controllers for industrial process automation.
22EEE72.5	Demonstrate knowledge of electric drives and motion control concepts used in industrial automation systems.
22EEE72.6	Conduct case studies to investigate modern trends, technologies, and challenges in automation, comparing with traditional approaches.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE72.1	3	2	2	-	2	-	-	-	-	-	-	-	1	1
22EEE72.2	3	2	2	-	2	-	-	-	-	-	-	-	1	1
22EEE72.3	3	2	2	-	2	-	-	-	-	-	-	-	1	1
22EEE72.4	3	2	2	-	2	-	-	-	-	-	-	-	1	1
22EEE72.5	3	2	2	-	2	-	-	-	-	-	-	-	1	1
22EEE72.6	3	2	2	-	2	-	-	-	-	-	-	-	1	1

MODULE-1	**INTRODUCTION TO PLC AND SCADA**	**22EEE72.1 22EEE72.6**	**8 Hours**

Need of SCADA systems, features of SCADA, Block diagram of SCADA, Function of SCADA, Network Protocols, Protocol standards, Serial Communication – Device Net – Control Net – EthernetRS232, RS48, Modbus – Fieldbus – Probus - Subnetting – Subnet mask - File transfer protocol.

Case study	Investigate the Challenges of Advanced PLC and SCADA, Compare with traditional areas of science and engineering.
Text Book	Text book 1: Ch 6 & Ch 7 Text book 3: Ch 1

MODULE-2	**BUILDING MANAGEMENT SYSTEM AND ENERGY MANAGEMENT SYSTEMS**	**22EEE72.2 22EEE72.6**	**8 Hours**

Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS-Functions of EMS and Block diagram of EMS.

Case study	Investigate Building management system and energy management systems
Text Book	Test book 3: Ch 2

MODULE-3	**HOME AUTOMATION SYSTEMS AND FIRE ALARM SYSTEMS**	**22EEE72.3 22EEE72.6**	**8 Hours**

Home automation system necessity-block diagram of home automation system-Introduction to Security Systems, Concepts-Components, Technology, Advanced Applications. Security Design-Concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components -Standards for communication: CBUS – KNX

FAS architecture: Types of Architecture and Examples. Fire Alarm System Devices and Standards

Case study	Survey on Home automation systems, design, applications.
Text Book	Test book 2: Ch 12 & Ch 3

MODULE-4	**PID CONTROL USING PLC**	**22EEE72.4**	**8 Hours**

Definition of PID, Use of PID controller, Block diagram, mathematical model/ Derivation, Working of PID controller, Tuning, PID in PLC programming, Digital PID controllers (using microcontrollers)

Application	Design a PID control system to maintain motor speed under varying load conditions.

Text Book	Test book 1: Ch 9, Ch 10		
MODULE-5	**ELECTRIC DRIVES AND MOTION CONTROL**	**22EEE72.5**	**8 Hours**
Role of drives in automation, Types of electric drives, Basic block diagram of a drive system, Concept of motion profiles, Feedback devices, Closed-loop control systems in industrial machines, Communication between drives and PLC.			
Self-study	Role of drives in automation		
Text Book	Text book 1: Ch 8		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Programmable Logic Controllers and Industrial Automation: An Introduction 2nd Edition, by Madhuchandranda Mitra and Samarjt Semgupta.12 July 2017.ISBN:978-8187972631
2) PLCs & SCADA: Theory and Practice by Rajesh Mehra, edition2018, ISBN-13: 978-9381159118 ISBN 10: 9381159114
3) Intelligent Building Systems by Albert Ting-Pat So, WaiLok Chan, Kluwer Academic publisher,3rd ed., 2012. ISBN:978-0792384915

Reference Books:

1) Understanding Building Automation Systems by Reinhold A. Carlson, Robert A. Di Giandomenico, pub. by R.S. Means Company, 1991.ISBN:978-0876292112
2) Industrial Process Automation Systems 1st Edition, by B.R. Mehta Y. Jaganmohan Reddy, 26 November 2014, ISBN:978-0128010983
3) Overview of Industrial Process Automation Paperback, by K.L.S. Sharma, 27 October 2016. ISBN:978-0128053546
4) Industrial Instrumentation Paperback, by K Krishnaswamy, S. Vijyachitra, 1 January 2020.ISBN:978-8122427509
5) Programmable Logic Controllers, By Frank D. Petruzella,2016, McGraw-Hill Science Engineering; 4th edition, ISBN: 0073303429

Web links and Video Lectures (e-Resources):

- https://standards.ieee.org/ieee/C37.1/4292/
- https://onlinecourses.swayam2.ac.in/nou25_ee04/preview
- https://onlinecourses.swayam2.ac.in/ntr25_ed92/preview

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

- Visit to any electrical machines automation industry or any power plant
- Video demonstration of latest trends in industry applications
- Real-World Case Study Discussion
- Technology Matching Game
- Seminar on home automation

ADVANCED INDUSTRIAL AUTOMATION AND CONTROL LABORATORY			
Course Code	**22EEL72**	**CIE Marks**	**50**
L: T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

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

22EEL72.1	Design the SCADA system for Industrial applications
22EEL72.2	Evaluate the problems in a building using building management systems (BMS) and energy management systems (EMS)
22EEL72.3	Apply the SFC based solutions for building a Smart industry
22EEL72.4	Analyze the configurations of CCTV, Fire alarm, access control system for a smart home

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEL72.1	3	2	2	3	3	-	-	-	-	-	-	-	1	1
22EEL72.2	3	3	3	3	3	-	-	-	-	-	-	-	1	1
22EEL72.3	3	3	3	3	3	-	-	-	-	-	-	-	1	1
22EEL72.4	3	3	3	3	3	-	-	-	-	-	-	-	1	1

Exp. No	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	• Industrial Automation • PLC • Digital Logic Circuits.	2	NA
	PART-A		
1	Design the lamp control using Screen operation and unity pro.	2	22EEL72.1
2	Design the temperature monitoring system using analog input module.	2	22EEL72.1
3	Design the basic animation in mimic screen using SCADA.	2	22EEL72.1
4	Execute the regulation of water treatment plant using SCADA.	2	22EL722.1
5	Design and configuration of Building Management Systems.	2	22EEL72.2
6	Apply Lua program to make the automatic HVAC systems.	2	22EEL72.2
	PART-B		
7	Design a basic Trolley control system in an industry using SFC.	2	22EEL72.3
8	Design a SFC for advanced control in trolley management.	2	22EEL72.3
9	Design of CCTV system for live monitoring and recording of videos using PELCO	2	22EEL72.4
10	Design and configuration of a pre-programming home automation system.	2	22EEL72.4
	PART-C		

Beyond Syllabus Virtual Lab Content
(To be done during Lab but not to be included for CIE or SEE)

1. Implementation of up - down counter
   https://plc-coep.vlabs.ac.in/exp/up-down-counter/
2. Implementation Of PLC Arithmetic Instructions
   https://plc-coep.vlabs.ac.in/exp/plc-arithmatic-instructions/
3. Implementation Of PID Controller
   https://plc-coep.vlabs.ac.in/exp/pid-controller/
4. Tune PID controller for heat exchanger using DCS

https://ial-coep.vlabs.ac.in/exp/heat-exchanger-dcs/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	5	5
L3	Apply	5	10
L4	Analyze	5	5
L5	Evaluate	5	10
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	10
L4	Analyze	20
L5	Evaluate	10
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Intelligent Building Systems by Albert Ting-Pat So, WaiLok Chan, Kluwer Academic publisher,3rd ed., 2012 ISBN, 1461550203, 9781461550204.
2) PLCs & SCADA: Theory and Practice by Rajesh Mehra, edition2018, ISBN-13: 978-9381159118 ISBN-10: 9381159114
3) Design of Special Hazards and Fire Alarm Systems by Robert Gagnon, Thomson Delmar Learning; 2nd edition, 2007. ISBN-13. 978-1418039509
4) Energy Management Handbook, Turner, W. C, 5th Edition, 2004th Edition8173-542-6

PHOTOVOLTAIC SYSTEMS AND APPLICATIONS			
Course Code	**22EEE73**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE73.1	Describe the basics of PV systems and its connections
22EEE73.2	Interpret the parameters of PV modules and their connections to form arrays
22EEE73.3	Analyze the design, integration and economics of PV systems
22EEE73.4	Demonstrate the importance of charge controllers and Maximum Power Point Tracking
22EEE73.5	Evaluate the Battery Management Systems and their necessity for remote applications of solar PV systems
22EEE73.6	Design the PV system as per the real time applications and requirements

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE73.1	3	2	2	2	-	-	-	-	-	-	-	1	1	2
22EEE73.2	3	2	2	2	2	-	-	-	-	-	-	1	1	2
22EEE73.3	3	2	2	2	2	-	-	-	-	-	-	1	1	2
22EEE73.4	3	2	2	2	2	-	-	-	-	-	-	1	1	2
22EEE73.5	3	2	2	2	2	-	-	-	-	-	-	1	1	2
22EEE73.6	3	2	2	2	2	-	-	-	-	-	-	1	1	2

MODULE-1	**SOLAR CELLS, PV MODULES AND ARRAYS**	**22EEE73.1, 22EEE73.2, 22EEE73.6**	**8 Hours**

Parameters of Solar Cells, Factors affecting Electricity generated from a Solar Cell, Solar PV Modules–Ratings, and Module Parameters. Factors Affecting Electricity Generated by a Solar PV Module, Measuring Module Parameters, Solar PV Module Arrays - Connection of Modules in Series, in Parallel and in Combination

Case study	Solar power generation in India
Text Book	Text Book 1: Ch 2, 3,4; Text Book 2: 1.1,5.1-5.4

MODULE-2	**SOLAR PV SYSTEM DESIGN**	**22EEE73.3**	**8 Hours**

Types of Solar PV Systems – Standalone, Grid-connected and Hybrid, Design Methodology for SPV System, Grid-connected Solar PV Power Systems – Introduction, Components and Configurations, Grid-connected PV System Design for Small Power Applications and for Power Plants. Economics of PV Systems-sample payback period, lifecycle costing.

Self-study	NA
Text Book	Text Book 1: Ch 10, 11; Text Book 2: 8.7-8.12

MODULE-3	**CHARGE CONTROLLER, MPPT AND INVERTERS**	**22EEE73.4, 22EEE73.6**	**8 Hours**

Need For Balance of System (BoS), Power Converters and their efficiency, DC to AC Converters (Inverters), DC to DC Converters, Charge Controllers, Maximum Power Point Tracking (MPPT), Types of Wires and Wire Sizing, Junction Box.

Self-study	Different power converters
Text Book	Text Book 1: Ch 8,9

MODULE-4	**BATTERIES AND THEIR APPLICATIONS TO SOLAR PV SYSTEMS**	**22EEE73.5, 22EEE73.6**	**8 Hours**

Types of batteries, Parameters of Batteries, Selection of a battery, Connecting Batteries together–Series, Parallel and mixed combination, Estimating Number of Batteries to be Connected in a battery Bank, Testing and Maintenance of Batteries, Fault Detection, Instruments used for Maintenance.

Case Study	Solar PV System, Environmental considerations of PV Systems
Text Book	Text Book 1: Ch 6

MODULE-5	**APPLICATIONS OF PV SYSTEMS**	**22EEE73.4, 22EEE73.5, 22EEE73.6**	**8 Hours**

Battery chargers, Domestic and Street lighting, Water pumping, Solar PV building heating and Solar furnaces, solar cooking, air conditioning and refrigeration applications, solar vehicles, solar PV systems in space and Solar green houses

Applications	Design a solar PV system for a particular application
Text Book	Text Book 2: Ch 22

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	--
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Chetan Singh Solanki PHI Learning Publications, 3rd Edition, 2015, ISBN: 9788120347113,
2) Solar PV Power and Solar Products hand book, NIIR Project Consultancy Services, Ajay Kumar Gupta, 1st Edition,2022, ISBN: 9788195577590
3) Photovoltaic Solar Energy: From Fundamentals to Applications, Angèle Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Wiley Publishers, 2016, ISBN: 978-1-118-92746-5

Reference Books:

1) Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki, PHI Learning Publications, 3rd Edition, 2015, ISBN: 9788120351110
2) Photovoltaic Systems Engineering, Roger A. Messenger and Amir Abtahi, Taylor and Francis Group Publications, 3rd Edition, 2017(CRC Press Reprint – 2020), ISBN 9780367736330

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ee71/preview
- https://archive.nptel.ac.in/courses/115/107/115107116/
- https://archive.nptel.ac.in/courses/117/108/117108141/

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

- Visit to any solar PV industry or power plant
- Demonstration of PV module, panel
- Video demonstration of latest trends in Solar PV
- Seminar on Factors Affecting Electricity Generated by a Solar PV Module

PROJECT PHASE - II

Course Code	**22EEE74**	**CIE Marks**	**100**
L: T:P:S	**0:0:10:0**	**SEE Marks**	**100**
Hrs / Week	**20**	**Total Marks**	**200**
Credits	**10**	**Exam Hours**	**03**

Course outcomes:

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

22EEE74.1	Identify the specified societal needs and categorize them into multi-disciplinary areas in engineering.
22EEE74.2	Conduct detailed review of industrial and societal needs to reach sustainable conclusions.
22EEE74.3	Integrate significant techniques and modern tools to solve complex real-world problems.
22EEE74.4	Evaluate the identified methodologies and select based on specific criteria.
22EEE74.5	Interpret the progress and outputs of the project through professional engineering reports and present it to a community or industry.
22EEE74.6	Demonstrates the ability to collaborate in team settings by analyzing roles, evaluating team dynamics, and creating effective task delegation strategies to achieve collective objectives.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
22EEE74.1	3	3	3	2	3	2	1	1	2	1	2	2	2	2
22EEE74.2	3	3	3	2	3	2	1	1	2	1	2	2	2	2
22EEE74.3	3	3	3	2	3	2	1	1	2	1	2	2	2	2
22EEE74.4	3	3	3	2	3	2	1	1	2	1	2	2	2	2
22EEE74.5	3	3	3	2	3	2	1	1	2	1	2	2	2	2
22EEE74.6	3	3	3	2	3	2	1	1	2	1	2	2	2	2

- Selection of a topic in area of interest ensuring it is feasible within students' skills, resources, and department guidelines.
- Problem identification and setting measurable objectives that project aims to achieve.
- Collection of research papers and analysing existing methods, noting limitations and identifying how project will add value.
- Decision on the tools, technologies, and step-by-step process, and draw a clear diagram showing project flow.
- Breaking down project into clear phases with dates to systematically track progress and stay organized.
- Procuring hardware, software, and lab slots needed for project, ensuring everything is ready before implementation.
- Developing and testing each module individually, debug systematically, and integrate modules carefully.
- Performing detailed testing, comparing results with expected values, and recording all findings clearly.
- Writing report with proper sections including objectives, methodology, results, and conclusions with references.
- Preparing a clear PPT and explaining project confidently while anticipating viva questions.

CIE Assessment Pattern (100 Marks)

RBT Levels		Marks Distribution	
		Review 1 (50 Marks)	**Review 2 (50 Marks)**
L1	**Remember**	-	**-**
L2	**Understand**	10	10
L3	**Apply**	10	10
L4	**Analyze**	10	10
L5	**Evaluate**	10	10
L6	**Create**	10	10

SEE Assessment Pattern (100 Marks)

RBT Levels		Exam Marks Distribution (100)
L1	**Remember**	-
L2	**Understand**	20
L3	**Apply**	20
L4	**Analyze**	20
L5	**Evaluate**	20
L6	**Create**	20

Syllabus of Eighth Semester BE

Professional Elective Course-III

NEURAL NETWORK AND FUZZY LOGIC IN ELECTRICAL ENGINEERING			
Course Code	**22EEE811**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE811.1	Understand the concepts of Neuron model and its terminologies
22EEE811.2	Develop the neural network models for single layer and multi-layer network
22EEE811.3	Apply ANN techniques to electrical load forecasting problem and control system problem
22EEE811.4	Analyze the operation of fuzzy based systems
22EEE811.5	Design the fuzzy logic algorithm for evaluating motor control, AVR operation and 18 bus bar system
22EEE811.6	Develop modern tools for understanding and implementation of neuro-fuzzy model

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE811.1	3	3	2	2	1	-	-	-	-	-	-	-	1	1
22EEE811.2	3	3	2	2	2	-	-	-	-	-	-	-	1	1
22EEE811.3	3	3	3	3	2	-	-	-	-	-	-	-	1	1
22EEE811.4	3	3	3	3	2	-	-	-	-	-	-	-	1	1
22EEE811.5	3	3	3	3	2	-	-	-	-	-	-	-	1	1
22EEE811.6	3	3	3	3	2	-	-	-	-	-	-	-	1	1

MODULE-1	**ARTIFICIAL NEURAL NETWORKS**	**22EEE811.1**	**8 Hours**
Basics of ANN - Comparison between Artificial and Biological Neural Networks – Basic Building Blocks of ANN – Artificial Neural Network Terminologies – McCulloch Pitts Neuron Model			
Self-study	NA		
Text Book	Text Book 1: 2.1 to 2.8		
MODULE-2	**SINGLE LAYER AND MULTI LAYER NETWORKS**	**22EEE811.2**	**8 Hours**
Learning Rules – ADALINE and MADALINE Models – Perception Networks – Back Propagation Neural Networks – Associative Memories.			
Applications	Investigate the different types of applications in industries with motors		
Text Book	Text Book 1: 2.10,3.1,3.2,4.5,4.6		
MODULE-3	**ANN APPLICATIONS TO ELECTRICAL ENGINEERING**	**22EEE811.3, 22EEE811.6**	**8 Hours**
ANN approach to: Electrical Load Forecasting Problem – System Identification –Control Systems – Pattern Recognition.			
Self-study	NA		
Text Book	Text Book 1: 2.10, 3.4, 4.6; Text Book: 14.1 -14.10		
MODULE-4	**FUZZY LOGIC**	**22EEE811.4**	**8 Hours**
Classical Sets – Fuzzy Sets – Fuzzy Properties and Operations – Fuzzy Logic System– Fuzzification – Defuzzification – Membership Functions – Fuzzy Rule base – Fuzzy Logic Controller Design.			
Self-study	NA		
Text Book	Text Book 1: 6.1 to 6.5, Text Book 2: 2,3; Text Book 4: 6,7		
MODULE-5	**FUZZY LOGIC APPLICATIONS TO ELECTRICAL ENGINEERING**	**22EEE811.5 22EEE811.6**	**8 Hours**
Fuzzy Logic Implementation for Induction Motor Control – Switched Reluctance Motor Control –Fuzzy Excitation Control Systems in Automatic Voltage Regulator – Fuzzy Logic Controller in an 18 Bus Bar System			
Self-study	Fuzzy Logic Implementation for switched reluctance motor control used in EVs		
Text Book	Text Book 1: 7.6, Text Book 2: 6,7; Text Book 4: 19		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Neural Network, Fuzzy Logic, and Genetic Algorithms, S. Rajasekaran and G.A. Vijayalakshmi Pai, PHI, New Delhi, 2016. ISBN:978-81-203-2186-1
2) Fuzzy Logic with Engineering Applications, Timothy J. Ross, "", Third Edition, WILEY India Edition, 2018, ISBN: 13. 978-0470743768.
3) Introduction to Fuzzy Logic using MATLAB, S. N. Sivanandam, S. Sumathi and S. N. Deepa, "", Springer International Edition, 2016, ISBN: 978-3-642-07144-7.
4) Intelligent System – Modeling, Optimization & Control, Yung C. Shin and Changing Xu, "", CRC Press, 2017. ISBN:978-1420051766.

Reference Books:

1) Introduction to Artificial Neural Network, Jacek M. Zurada, Jaico Publishing House, New Delhi, Third Edition, 2019, ISBN: 9788172242664.
2) Fundamentals of Soft Computing, Vinoth Kumar K, S.K.Kataria and Sons Publishers, New Delhi, Second Edition, 2020, ISBN: 978-9350141168.

Web links and Video Lectures (e-Resources):

- https://au.mathworks.com/academia/books/introduction-to-neural-networks-using-matlab-sivanandam.html
- https://www.coursera.org/learn/neural-networks-deep-learning
- https://nptel.ac.in/courses/117105084
- https://highered.mheducation.com/sites/0070591121/student_view0/
- https://neuroph.sourceforge.net/
- https://cofes.com/neural-network-software/

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

- Video demonstration of latest trends in industry applications
- Visit to any AI based industries of electrical applications
- Industrial Case Study Hunt
- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Seminars on fuzzy logic applications to electrical engineering
- IBM academic initiatives

MACHINE LEARNING FOR ELECTRICAL ENGINEERING			
Course Code	**22EEE812**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE812.1	Understand the basics of machine learning
22EEE812.2	Apply the different learning algorithms for prediction
22EEE812.3	Develop skills to analyze and evaluate the performance of machine learning models using appropriate metrics and techniques.
22EEE812.4	Design a model to solve classification /clustering problems using supervised or unsupervised machine learning algorithms.
22EEE812.5	Evaluate the performance of various machine learning algorithms using different real world data sets.
22EEE812.6	Apply machine learning algorithms for solving practical applications related to electrical engineering

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE812.1	3	-	-	-	**2**	-	-	-	-	-	-	-	1	1
22EEE812.2	3	-	-	-	2	-	-	-	-	-	-	-	1	1
22EEE812.3	3	3	-	-	2	-	-	-	-	-	-	-	1	1
22EEE812.4	3	3	3	-	2	-	-	-	-	-	-	-	1	1
22EEE812.5	3	3	3	3	2	-	-	-	-	-	-	3	1	1
22EEE812.6	3	3	3	3	3	-	-	-	-	-	-	3	1	1

MODULE-1	**INTRODUCTION TO MACHINE LEARNING**	**22EEE812.1 22EEE812.2**	**8 Hours**

Introductions to Machine Learning: Terminologies in machine learning, Applications, Types of machine learning: supervised, unsupervised, semi-supervised learning, Reinforcement Learning. Features: Types of Data (Qualitative and Quantitative), Scales of Measurement (Nominal, Ordinal, Interval, Ratio), Concept of Feature, Feature construction, Feature Selection and Transformation, Curse of Dimensionality. Linear discriminate Analysis (LDA).

Case study	Email Spam Detection System
Text Book	Text Book 1: Ch 1

MODULE-2	**SUPERVISED LEARNING**	**22EEE812.1 22EEE812.2 22EEE812.3 22EEE812.4**	**8 Hours**

Binary Classification & Evaluation, Support Vector Machines (SVM), Multi-class Classification, Decision Trees, Regression, Other Classifiers & Model Issues

Self-Study	Understand the Linear Algebra and Calculus: concepts like vectors, matrices, derivatives, and gradients.
Text Book	Text Book 1: Ch 2, Text Book 2: Ch 3.1,3.2,3.3,6.3,8.2

MODULE-3	**UNSUPERVISED LEARNING**	**22EEE812.1 22EEE812.2 22EEE812.3 22EEE812.4**	**8 Hours**

Distance Based Models: Distance Metrics (Euclidean, Manhattan, Hamming, Minkowski Distance Metric), Clustering as Learning task: K-means clustering Algorithm-with example, k-medoid algorithm with example. Principal Component analysis (PCA).

Self-Study	Customer Segmentation in a Retail Store
Text Book	Text Book 2: Ch 6

MODULE-4	**TRENDS IN MACHINE LEARNING**	**22EEE812.5**	**8 Hours**

Ensemble Learning- Combining Multiple models, bagging, boosting, stacking-Algorithms-Random Forest, ada-boost. Introduction to Reinforcement Learning –Exploration, exploitation, rewards, penalties

Self-Study	Loan Default Prediction Using Ensemble Learning
Text Book	Text Book 1: Ch 17, Text book 2: Ch 13

MODULE-5	APPLICATIONS OF ML TECHNIQUES	22EEE812.5 22EEE812.6	8 Hours

Machine learning applications to electrical engineering: Electrical load forecasting, wind and solar energy forecasting, fault identification and classification, reinforcement learning for control, Image classification and segmentation.

Applications	Discuss how machine learning can contribute to energy efficiency and conservation efforts.
Text Book	Text book 3: Ch 15

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Introduction to Machine, E. Alpaydin Learning, PHI, 2005. ISBN 978-0-262-02818-9.
2) Machine Learning, Tom Mitchell, New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
3) Machine Learning Algorithms and Applications in Engineering, P. Chaterjee, M.Yazdani, F F Navarro, JP Rodriguez, 2025, CRC press, 1st edition, ISBN: 9780367569129.

Reference Books:

1) Machine Learning, T. Mitchell, McGraw Hill. 2017, ISBN: 978-1259096952
2) Introduction to Machine Learning, Alex Smola, S.V.N. Vishwanathan, Cambridge University Press 2008. ISBN 0 521 82583 0.
3) Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2009, ISBN-978-1493938438

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106106198
- https://onlinecourses.nptel.ac.in/noc21_cs24/preview
- https://onlinecourses.nptel.ac.in/noc23_ee87/preview

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

- Flipped class room teaching method
- For active participation of students, instruct the students to read research topics on Machine Learning
- Seminars on applications of ml techniques

QUANTUM COMPUTING			
Course Code	**22EEE813**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE813.1	Understand the fundamental principles and architecture of quantum computing
22EEE813.2	Describe the foundational concepts of quantum mechanics relevant to quantum computing
22EEE813.3	Compare classical and quantum computational models and analyze their complexity
22EEE813.4	Design and simulate quantum circuits using standard quantum gates
22EEE813.5	Evaluate the effects of quantum noise and apply error correction techniques
22EEE813.6	Justify the need for quantum computing in solving complex engineering and computational problems.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE813.1	3	2	2	2	1	-	-	-	-	-	-	-	1	1
22EEE813.2	3	3	1	2	1	-	-	-	-	-	-	-	1	1
22EEE813.3	3	2	2	2	1	-	-	-	-	-	-	-	1	1
22EEE813.4	3	2	1	2	1	-	-	-	-	-	-	-	1	1
22EEE813.5	3	3	2	2	1	-	-	-	-	-	-	-	1	1
22EEE813.6	3	2	1	2	1	-	-	-	-	-	-	-	1	1

MODULE-1	**INTRODUCTION TO QUANTUM COMPUTING**	**22EEE813.1, 22EEE813.6**	**8 Hours**
Introducing quantum mechanics: Introduction & Types of Computing, History of Classical and Quantum Computing, Quantum Kinematics and Dynamics, Quantum Measurements, Single Qubit and Multi-Qubit Systems, Basic Quantum Gates.			
Self-study	Simulating a Quantum Circuit for a Simple Algorithm		
Text Book	Text Book 1: 1.2, 1.3, 2.1,2.2,2.3,2.4,2.5,3.2		
MODULE-2	**MATRICES AND OPERATORS**	**22EEE813.2**	**8 Hours**
Introduction to Linear Algebra for Quantum Computing- Vectors and vector spaces, Dirac notation (bra-ket), Inner product and orthogonality, Matrix Operations and Properties, Special Matrices in Quantum Mechanics: Hermitian matrices, Unitary matrices, Diagonal and sparse matrices, Eigenvalues and Eigenvectors, Quantum Operators and Observables, Tensor Products and Composite Systems.			
Case study	Quantum State Evolution in a 2-Qubit System		
Text Book	Text Book 1: 2.2,1.1,4.2,3.4		
MODULE-3	**QUANTUM CRYPTOGRAPHY**	**22EEE813.3, 22EEE813.5**	**8 Hours**
Cryptography, Classical cryptography, Introduction to quantum cryptography. BB84, B92 protocols. Introduction to security proofs for these protocols, Quantum key distribution, Quantum error correction.			
Case study	Compare classical public-key cryptography (RSA, ECC) with quantum-safe alternatives (lattice-based, code-based cryptography) and QKD.		
Text Book	Text Book 1:8.1,8.4,9.1,9.2,9.3, Text Book 1:5.9		
MODULE-4	**QUANTUM GATES AND ALGORITHMS**	**22EEE813.4**	**8 Hours**
Quantum gates and algorithms: Universal set of gates, Quantum circuits, Single Qubit Gates: Quantum Not Gate, Pauli-X, Y, Z Gates, Hadamard Gate, Phase Gate or S Gate, T Gate, Multiple Qubit Gates: Controlled Gates, CNOT Gate, Swap Gate, Controlled Z Gate, Toffoli Gate.			
Self-study	Design and Simulation of a Quantum Half-Adder Using Quantum Gates		
Text Book	Text Book 1: 11.3,12.1,12.2		
MODULE-5	**QUANTUM ALGORITHMS**	**22EEE813.3, 22EEE813.6**	**8 Hours**
Classical computation on quantum computers, Relationship between quantum and classical complexity classes, Deutsch-Jozsa algorithm, Grover's quantum search algorithm, Simon's algorithm, Shor's quantum factorization algorithm, Bernstein Vazirani Algorithm.			
Application	Breaks widely-used classical encryption schemes like RSA, DSA, and ECC		

Text Book	Text Book 3: 11.3,11.4,11.6,11.8,11.15

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	10	5
L4	Analyze	5	5	5
L5	Evaluate	5	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Mastering Quantum Computing: Practical Applications and Programming, Edward Franklin, Madison Matti Charlton, Telephasic Workshop, 2024, ISBN: 978-1778901973.
2) Quantum Computing from Colossus to Qubits: The History, Theory, and Application of a Revolutionary Science, John Gribbin, 2024, ISBN: 978-1633888708.
3) Quantum Computing: A New Era of Computing, Kuldeep Singh Kaswan, Jagjit Singh Dhatterwal, Anupam Baliyan, Shalli Rani, Wiley-IEEE Press, July 2023, ISBN: 978-1394157815.

Reference Books:

1) Introductory Quantum Computing: A Practical Approach Using Python, Nikhil Ranjan Roy, Kuntal Mukherjee, S Chand and Company Ltd, 2024, ISBN: 978-9358706994

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106106232
- https://www.coursera.org/learn/introduction-to-quantum-information
- https://www.udemy.com/course/quantum-computers/?couponCode=THANKSLEARNER24

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

- NPTEL course
- Organizing Group wise discussions on cryptography
- Quantum vs. Classical – Concept Mapping Challenge
- For active participation of students, instruct the students to solve and analyze various algorithms

POWER SYSTEM OPERATION AND CONTROL

Course Code	**22EEE814**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE814.1	Understand real power control and operation.
22EEE814.2	Analyze the response of single area and two area systems.
22EEE814.3	Evaluate the reactive power and voltage control in power system.
22EEE814.4	Optimize the scheduling of generation units.
22EEE814.5	Apply different methods to solve unit commitment problem.
22EEE814.6	Develop the models for computer control of power systems and data acquisition.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE814.1	3	-	-	-	2	-	-	-	-	-	-	2	1	2
22EEE814.2	3	3	-	-	2	-	-	-	-	-	-	2	1	2
22EEE814.3	3	3	1	2	2	-	-	-	-	-	-	2	1	2
22EEE814.4	3	3	-	2	2	-	-	-	-	-	-	2	1	2
22EEE814.5	3	3	-	2	2	-	-	-	-	-	-	2	1	2
22EEE814.6	3	3	-	2	2	-	-	-	-	-	-	2	1	2

MODULE-1	**INTRODUCTION**	**22EEE814.1 22EEE814.2**	**8 Hours**

Structure of Electric Energy System, Operating States of Power System, Transmission Capacity. Load Characteristics: Voltage and Frequency Load Dependency. The Real Power Balance and its Effect on System Frequency. The Reactive Power Balance and its Effect on System Voltage. Control of Generation: Megawatt-frequency and Mega -voltage control, Generator Model, Load Model, Prime-Mover Model, Governor Model.

Self-study	Reactive power compensation methods
Text Book	Text Book 1: 3.1, 2.2, 3.3, 3.4, 3.5, 3.6, to 3.11

MODULE-2	**LOAD FREQUENCY CONTROL**	**22EEE814.2**	**8 Hours**

Speed-Load characteristics of Governor, Parallel operation of Generators, Concept of Control Area. Megawatt-Frequency Control of Single Area: the uncontrolled and controlled case. The two-area system: Block diagram of two area system. Static and Dynamic response of uncontrolled two-area system, Static and Dynamic response of controlled two-area system.

Self-study	Static and Dynamic response in power system
Text Book	Text Book 3: 3.1 to 3.23

MODULE-3	**REACTIVE POWER AND VOLTAGE CONTROL**	**22EEE814.3**	**8 Hours**

Production and absorption of reactive power, Methods of Voltage Control, Shunt reactors Shunt Capacitors, Series Capacitors Synchronous condensers, Static VAR systems, Principles of Transmission system compensation, Modeling of reactive compensating devices, Application of tap changing transformers to transmission systems, Distribution system voltage regulation, Modeling of transformers ULTC control systems.

Application	Application of tap changing transformers to transmission systems
Text Book	Text Book 3: 2.1 to 2.23

MODULE-4	**ECONOMIC DISPATCH OF THERMAL UNITS AND UNIT COMMITMENT**	**22EEE814.4**	**8 Hours**

Optimal operation of Generators in Thermal Power Stations, heat rate Curve – Cost Curve – Incremental fuel and Production costs, input-output characteristics, Optimum generation allocation with line losses neglected using Lagrangian function. Optimum generation allocation including the effect of transmission line losses – Loss Coefficients, General transmission line loss formula. Unit Commitment: Constraints in Unit Commitment, Spinning Reserve, Thermal Unit Constraints, Hydro-Constraints, Must Run Constraint & Fuel Constraints. Unit Commitment Solution Methods: Priority List, Lagrange Relaxation Solution.

Case Study	Economic Dispatch of Thermal Power Plant
Text Book	Text Book 1: 4.1 to 4.29

MODULE-5	POWER SYSTEM SECURITY& MODERN TRENDS IN POWER SYSTEM CONTROL	22EEE814.5, 22EEE814.6	8 Hours

Factors affecting Power System Security, Linear Sensitivity Factors (LSFs). Contingency Analysis using LSFs, Numerical Problems**.** Energy Management Systems, SCADA Control of the Indian Power Grid, Role of Load Dispatch Centers, Synchro-phasors**,** Phasor Measurement Unit (PMU)**,** Wide Area Monitoring System (WAMS), Overview of WAMS in Indian Grid.

Case Study	Relay Coordination and Contingency Analysis
Text Book	Text Book 1: 10.1 to 10.7

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	5
L2	Understand	5
L3	Apply	15
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Power Generation Operation and Control, Allen J.Wood, Bruce.F.Wollenberg, Gerald B. ShebléWiley & Sons, 2013, ISBN: 0471586994.
2) Electric Energy Systems Theory, Elgerd.O.I McGraw Hill Education; Second Edition, 2017. ISBN: 007099286X.
3) Reactive Power Control in Electric Systems, Timothy J. E. Miller, Wiley, First Edition, Reprint 2010, ISBN: 13: 978-8126525201.

Reference Books:

1) EPRI Power System Dynamics Tutorial, Electric Power Research Institute, Jul 27, 2009.
2) Unified Real Time Dynamic State Measurement (URTSM), Power Grid Corporation of India, Feb 2012.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/104/108104052/
- https://onlinecourses.nptel.ac.in/noc23_ee128/preview

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

- Video demonstration of the concepts of power system operation and control.
- Organizing group wise discussions on effect of reactive power in power system.
- Seminars on power system security.
- Industrial visit to substation

POWER QUALITY			
Course Code	**22EEE815**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE815.1	Understand different types of power quality problems with its source of generation.
22EEE815.2	Interpret results of power quality monitoring equipment and classify the power quality disturbances.
22EEE815.3	Evaluate the operation of active and passive filters for harmonic elimination.
22EEE815.4	Solve power quality problems using power quality equipment's.
22EEE815.5	Develop understanding on the role of compensations in improving power quality.
22EEE815.6	Analyze the impact of nonlinear loads such as VFDs, rectifiers on power quality.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE815.1	2	3	2	1	1	-	-	-	-	-	-	1	2	1
22EEE815.2	3	3	2	1	3	-	-	-	-	-	-	1	2	1
22EEE815.3	3	3	3	3	3	-	-	-	-	-	-	1	2	1
22EEE815.4	3	3	3	2	2	-	-	-	-	-	-	1	2	1
22EEE815.5	3	3	2	3	3	-	-	-	-	-	-	1	2	1
22EEE815.6	3	3	2	3	3	-	-	-	-	-	-	1	2	1

MODULE-1	**ELECTRIC POWER QUALITY PHENOMENA**	**22EEE815.1**	**8 Hours**

Introduction to power quality, IEEE and IEC - EMC standards, overview, sources and impact of power quality disturbances – RMS voltage variations, interruptions, voltage fluctuation, transients, waveform distortion and power frequency variations.

Self-study	Power quality issues
Text Book	Text Book 1: 1.1,1.2,1.3, 2.2, 2.3, 2.7, 2.8, 2.9 Text Book 2: 1.4

MODULE-2	**POWER QUALITY MONITORING**	**22EEE815.2**	**8 Hours**

Monitoring considerations, Historical Perspective of Power quality Measuring Instruments, Power Quality Measurement Equipment, Assessment of Power Quality Measurement Data, Application of intelligent Systems, Power Quality Monitoring Standards, Monitoring considerations.

Self-study	Power Quality Monitoring Standards
Text Book	Text Book 1: 11.1, 11.2, 11.3,11.4 Text Book 2: 6.3

MODULE-3	**VOLTAGE SAGS AND INTERRUPTIONS**	**22EEE815.2, 22EEE815.4,**	**8 Hours**

Sources of Saga and Interruptions, estimating voltage Sag Performance, Fundamental Principles of Protection, Solution at the End-User Level, Motor ‑Starting Sags

Case study	Voltage Sags in a Textile Manufacturing Plant
Text Book	Text Book 1: 3.1, 3.2, 3.3, 3.5 Text Book 2: 4.2,4.3,4.4, 7.1, 7.4

MODULE-4	**HARMONICS**	**22EEE815.3, 22EEE815.6**	**8 Hours**

Sources, Definitions and Terms Standards and Measures Impacts, System Response, Modelling of networks and components under non-sinusoidal conditions, loads that may cause power quality problems. Mitigation and Control Techniques, Filtering (passive and active), Examples and Case Studies Harmonic Studies

Self-Study	Basic concepts of filters
Text Book	Text Book 1: 5.1, 5.2, 5.3, 5.4, 5.7, 5.10, 6.2, 6.3,

MODULE-5	**CUSTOM POWER DEVICES**	**22EEE815.4, 22EEE815.5**	**8 Hours**

Introduction to shunt and series compensators, DSTATCOM, Dynamic Voltage Restorer (DVR) and Unified Power Quality Conditioner (UPQC).

Self-study	Reactive power, Series and Shunt compensation devices

Text Book	Text Book 1: 7.4, Text Book 4: 7.1, 7.2, 8.1, 8.2, 10.1, 10.2

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Electrical Power System Quality, Dugan R. C., Mc Granaghan M. F. Surya Santoso, and Beaty H. W, McGraw-Hill, 3rd Edition, 2003. ISBN: 9780071761550.
2) Understanding Power Quality Problems: Voltage sags and interruptions, Math H. Bollen, IEEE Press, New York, 2000, Online ISBN: 9780470546840, Print ISBN: 9780780347137.
3) Power Quality: Problems and Mitigation Techniques, Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Wiley, 2015.ISBN:9781118922064
4) Power quality enhancement using custom power devices, Ghosh, Arindam, and Gerard Ledwich, Springer Science & Business Media, 2012, ISBN: 978-1-4615-1153-3

Reference Books:

1) Power Quality in Power Distribution Systems Concepts and Applications, Mishra, Mahesh Kumar, CRC Press, Taylor & Francis, New York, 2024, ISBN 9781032617299
2) Power System Quality Assessment, Arrillaga, J., Watson, N. R., Chen, S., Wiley, 2011, ISBN: 978-0-471-98865-6.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/102/108102179/
- https://gcebargur.ac.in/sites/gcebargur.ac.in/files/lectures_desk/electrical_power_systems_quality.pdf

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

- Voltage Sag Simulation & Mitigation Challenge
- Organizing Group wise discussions on power quality issues and remedies
- Seminar on harmonics and mitigation methods

Professional Elective Course-IV

FACTS AND HVDC TRANSMISSION			
Course Code	**22EEE821**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE821.1	Understand the fundamentals of FACTS, power flow and stability considerations, and types of FACTS controllers.
22EEE821.2	Describe the objectives, methods, and operating principles of shunt compensation using various FACT controllers
22EEE821.3	Illustrate the concepts, objectives, and principles of series compensation using combined compensators in power transmission systems.
22EEE821.4	Analyze the economic, technical, and reliability aspects of AC vs. HVDC transmission systems
22EEE821.5	Apply the control strategies of HVDC converters and systems in HVDC transmission.
22EEE821.6	Evaluate the operation of HVDC converter systems for voltage stability

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE821.1	3	2	1	1	2	-	-	-	-	-	-	1	2	2
22EEE821.2	3	3	1	1	3	-	-	-	-	-	-	1	2	2
22EEE821.3	3	2	1	1	3	-	-	-	-	-	-	1	2	2
22EEE821.4	3	3	1	1	3	-	-	-	-	-	2	1	2	2
22EEE821.5	3	2	1	1	3	-	-	-	-	-	-	1	2	2
22EEE821.6	3	2	1	1	3	-	-	-	3	3		1	2	2

MODULE-1	**FACTS FUNDAMENTALS**	**22EEE821.1**	**8 Hours**

Introduction to FACTS, Flow of Power in an AC System, Limitations on Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Basic Definitions of FACTS Controllers, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.

Self-study	FACTS controllers
Text Book	Text Book 1: 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9

MODULE-2	**SHUNT COMPENSATION**	**22EEE821.2**	**8 Hours**

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

Self-study	Transient stability improvement techniques
Text Book	Text Book 1 :5.1,5.2,5.3,5.4,5.5

MODULE-3	**SERIES COMPENSATION**	**22EEE821.3**	**8 Hours**

Objectives of series compensation, Concept of Series Capacitive Compensation, Basic operation of Thyristor Switched Series Capacitors (TCSC), Basic operating principle of Static synchronous Series Compensator (SSSC). Combined Compensators: Unified power flow controller (UPFC) – Introduction, operating principle. Interline power flow controller (IPFC) – Introduction, operating principle

Application	Reactive power compensation techniques in power system
Text Book	Text Book 1:6.1,6.2,6.3,6.4,6.5

MODULE-4	**HVDC TRANSMISSION**	**22EEE821.4**	**8 Hours**

Comparison of AC and DC Transmission-Economics of power transmission-Technical Performance-Reliability, Application of DC transmission, Description of DC transmission system-Types of DC links-Converter station, planning for HVDC transmission, Modern trends in HVDC technology, Power Conversion:3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter.

Self-Study	Applications using different types of HVDC links on AC grid

Text Book	Text Book 2:3.1,3.2,3.3,3.4,3.5, 3.6		
MODULE-5	**CONTROL OF HVDC CONVERTER AND SYSTEM**	**22EEE821.5, 22EEE821.6**	**8 Hours**
Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.			
Applications	Design a HVDC converter control on voltage stability		
Text Book	Text Book 2:4.1,4.2,4.3,4.4,4.5, 4.6, 4.7, 4.8		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Concepts and Technology of Flexible AC Transmission System, Hingorani, L.Gyugyi, ‘, IEEE Press New York,1st Edition, 2011. ISBN: 978-0780334557
2) HVDC transmission systems, Padiyar, K.R., ‘, Wiley Eastern Ltd., 3rd Edition, 2021, ISBN: 978-8122437850

Reference Books:

1) High voltage Direct Current Transmission, Jos Arrillaga, IET Power and Energy Series 29,2nd Edition,1998, ISBN: 978-0852969410
2) FACTS controllers for Transmission and Distribution systems, Padiyar K.R., ‘’ New Age International Publishers, 1st Edition, 2007. ISBN: 978-1848290105
3) Flexible AC Transmission Systems (FACTS), Song, Y.H. and Allan T. Johns, Institution of Electrical Engineers Press, London,1st Edition, 1999. ISBN: 978-0852967713
4) FACTS –Modeling and simulation in Power Networks, Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho , John Wiley & Sons, 1st Edition, 2002. ISBN: 978-0-470-02015-9

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108104013
- https://nptel.ac.in/courses/108107114
- https://archive.nptel.ac.in/courses/108/107/108107114/

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

- Visit to any power grid substation on Facts and HVDC transmission
- Demonstration of installation of Facts devices
- Video demonstration of modern trends in Facts and HVDC transmission
- Group wise discussions on grid integration of facts and HVDC

TESTING AND COMMISSIONING			
Course Code	**22EEE822**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE822.1	Understand the maintenance schedule plan of different equipment and machines and earthing process.
22EEE822.2	Demonstrate understanding of testing procedures and maintenance practices for large rating transformers.
22EEE822.3	Describe the different types of testing for various electrical installations.
22EEE822.4	Evaluate and rectify the faults in rotating machines.
22EEE822.5	Analyze power cable specifications, laying and testing of the electrical equipment.
22EEE822.6	Recommend switchgear accessories and protection equipment for high voltage transmission construction.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE822.1	3	2	1	1	2	-	-	-	-	-	-	1	1	1
22EEE822.2	3	2	1	1	2	-	-	-	-	-	-	1	1	1
22EEE822.3	3	2	1	1	2	-	-	-	-	-	-	1	1	1
22EEE822.4	3	2	1	1	2	-	-	-	-	-	-	1	1	1
22EEE822.5	3	2	1	1	2	-	-	-	-	-	-	1	1	1
22EEE822.6	3	2	1	1	2	-	-	-	-	-	-	1	1	1

MODULE-1	**SAFETY MANAGEMENT AND INSTALLATION**	**22EEE822.1**	**8 Hours**

Safety Management during Operation and Maintenance, Clearance and creepages, Factors affecting the Earth Resistance, methods of measuring the Earth Resistance, Equipment Earthing and System rounding, Earthing Procedure - Building installation, Domestic appliances, Industrial premises, Earthing of substation, generating station and overhead line, Inspection of Electrical Equipment at site, Storage Electrical Equipment at site, Alignment of Electrical Machines, Tools/Instruments necessary for installation, Technical report, Inspection, storage and handling of transformer, switchgear and motors

Self-study	Earthing procedures
Text Book	Text Book 1: Ch.7 Text Book 2: 5.1

MODULE-2	**TRANSFORMERS**	**22EEE822.2**	**8 Hours**

Construction of transformers-terminal marking, cooling arrangement, Routine tests, measurement of winding resistance, impedance, voltage ratio, insulation resistance, type tests, impulse voltage test, measurement of losses, temperature test, installation and commissioning of transformers, foundation, codes of practice, earthing, testing of oil strength

Applications	Choose the corrective and preventive maintenance and installation of power transformer.
Text Book	Text Book 2: 1.5,1,5.2

MODULE-3	**ROTATING MACHINES**	**22EEE822.3**	**8 Hours**

Introduction to Degree of protection, cooling system of rotating machines, commissioning and protection of induction motor and rotating electric machine, drying out of electric rotating machine, Pre and post commissioning checks, Routine tests and type tests, resistance measurement, mechanical tests Excitation test, over-speed test, generator and motor operation, sudden short circuit test, bearing currents.

Self-study	Test on rotating machines
Text Book	Text Book 2: 1.4, 1.7

MODULE-4	**UNDERGROUND CABLES**	**22EEE822.4**	**8 Hours**

Inspection, Storage, Transportation and Handling of Cables, Cable Handing Equipment, Cable Laying Depths and Clearances from other Services such as Water Sewerage, Gas, Heating and other Mains, Series of Power and Telecommunication Cables and Coordination with these Services, Excavation of Trenches, Cable Jointing and Terminations Testing and Commissioning, Effect of Open or Loose Neutral Connections, Provision of Proper Fuses on Service Lines and Their Effect on System.

Self-Study	Applications using different ways for testing and installation of cables
Text Book	Text Book 1: Ch 15 Text Book 2: 7.11,7.14

MODULE-5	HIGH VOLTAGE EQUIPMENTS	22EEE822.5, 22EEE822.6	8 Hours

Standards, Classification, specification, rating and duties of CB, installation, commissioning tests, Earthing resistance measurement, Substation grid Earthing, Soil resistivity measurement, testing of isolator- Temp. Resistance test, short circuit test, charging current making & breaking test, Inductive current making & breaking test

Self-study	High voltage equipment standards
Text Book	Text Book 2: 7.2,7.3

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Testing, Commissioning & maintenance of electrical equipment, S. S. Rao, Khanna Publications,6 th Edition, 19th Reprint, 2015, ISBN-13-978-8174091857
2) Testing and Commissioning of Electrical Equipment, R.L. Chakrasali, Prism Books Pvt Ltd, 1st Edition ,2014, ISBN-13: 978-8172868420

Reference Books:

1) The commissioning of Electrical Plant by RCH Richardson (Chapman & Hall),4th edition, ISBN- 041202280X
2) Installation Commissioning & Maintenance of Electrical Equipments, Tarlok Singh,S.K. Kataria & Sons,2nd edition ,2022, ISBN-978-93-5014-377-3
3) Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and Commissioning of electrical equipment's/machines

Web links and Video Lectures (e-Resources):

http://www.bis.org.in/index.asp
http://164.100.105.199:8071/php/BIS/IndStndrdLocatr/StandrdsSelection.php
http://www.ieee.org/publications_standards/publications_standards_index.html
http://www.nema.org/Standards/About-Standards/pages/default.aspx

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

- Visit to any electrical testing and installation manufacturing industry or any power plant.
- Demonstration of installation of machines.
- Video demonstration of latest trends in industry applications
- Seminar on high voltage equipments
- Organizing Group wise discussions on installation and maintenance on machines

ENERGY AUDITING AND DEMAND SIDE MANAGEMENT			
Course Code	**22EEE823**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

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

22EEE823.1	Analyze energy situation nationally and internationally
22EEE823.2	Conduct economic analysis in energy sector
22EEE823.3	Understand the importance of energy management techniques and energy audit process
22EEE823.4	Comprehend the need of energy conservation in real world scenario
22EEE823.5	Collaborate effectively in teams to analyze energy consumption and evaluate efficiency measures in industrial and commercial establishments.
22EEE823.6	Apply the knowledge of demand side management in real life applications

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE823.1	3	3	2	2	2	-	-	-	-	-	1	2	1	1
22EEE823.2	3	3	2	2	2	-	-	-	-	-	1	2	1	1
22EEE823.3	3	3	2	2	2	-	-	-	-	-	1	2	1	1
22EEE823.4	3	3	2	2	2	-	-	-	-	-	1	2	1	1
22EEE823.5	3	3	2	2	2	-	-	-	-	-	1	2	1	1
22EEE823.6	3	3	2	2	2	-	-	-	-	-	1	2	1	1

MODULE-1	**INTRODUCTION**	**22EEE823.1**	**8 Hours**

Energy Scenarios, Energy situation – world and India, Energy conservation, Energy consumption, Energy security, Energy strategy, clean development mechanism, Codes, Standards and Legislation.

Self-study	Need of energy conservation
Textbook	Textbook 1: 1, 1.1, 1.3, 1.6, 1.7,1.8

MODULE-2	**ENERGY ECONOMIC ANALYSIS**	**22EEE823.2**	**8 Hours**

The time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit – numerical problems.

Self-Study	General principles of energy management and energy management planning
Textbook	Textbook 3: 4.1, 7.2

MODULE-3	**ENERGY AUDITING AND ELECTRICAL SYSTEM OPTIMIZATION**	**22EEE823.3, 22EEE823.5**	**8 Hours**

Introduction, Elements of energy audits, Energy use profiles, Measurements in energy audits, Presentation of energy audit results, The power triangle, Motor horsepower, Power flow concept. Electrical Equipment and power factor –correction & location of capacitors.

Self-study	Power factor correction methods
Textbook	Textbook 2: 1.2, 1.8, 1.9

MODULE-4	**ENERGY CONSERVATION IN INDUSTRIES AND COMMERCIAL ESTABLISHMENTS**	**22EEE823.4, 22EEE823.5**	**8 Hours**

Motivation of energy conservation, Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation, Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.

Self-Study	Lighting: Modern energy efficient light sources
Textbook	Textbook 4: Ch 1.1,1.2,1.3

MODULE-5	**DEMAND SIDE MANAGEMENT**	**22EEE823.6**	**8 Hours**

Introduction to DSM, concept of DSM, benefits of DSM, different Techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning, Load management, load priority technique, peak

clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. Management and Organization of Energy.	
Self-study	Ancillary services: Introduction of ancillary services – Types of Ancillary services
Text Book	Text Book 5:1.5.1, 2.1

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Handbook on Energy Audit, Sonal Desai, McGraw Hill Publications, 2018. ISBN:9789339221331
2) Energy Audit and Management, L Ashok Kumar, Gokul Ganeshan, CRC Press, 1st Edition, 2023, ISBN: 978103206779
3) An Introduction to Energy Economics and Policy, Massimo Filippini, Suchita Srinivasan, Cambridge University Press, 2024, ISBN: 9781009471831
4) Energy Conservation in Residential, Commercial and Industrial Facilities, Hossam Gabbar, Wiley Publications, 1st Edition, 2018, ISBN: 9781119422068
5) Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern Ltd., New Delhi,2005, ISBN: 9788122402025

Reference Books:

1) Demand Side Management Jyothi Prakash, TMH Publishers
2) Hand book on energy auditing - TERI (Tata Energy Research Institute), 2000, ISBN: 818541971X

Web links and Video Lectures (e-Resources):

- https://www.npti.gov.in/en/training-programes
- https://onlinecourses.nptel.ac.in/noc25_hs136/preview

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

- Seminar on energy conservation methods
- For active participation of students, instruct the students to prepare energy audit report
- Organizing Group wise discussions on energy management

UTILIZATION OF ELECTRICAL ENERGY			
Course Code	**22EEE824**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE824.1	Explain the principles, working, and applications of electric heating and welding systems.
22EEE824.2	Design illumination systems for various indoor, outdoor, and industrial applications considering efficiency and lighting standards.
22EEE824.3	Evaluate electric drives and traction systems for different load and operational requirements.
22EEE824.4	Apply principles of refrigeration and air conditioning systems in practical scenarios.
22EEE824.5	Analyze the impact of energy conservation strategies and evaluate effective energy management practices.
22EEE824.6	Integrate simulation and practical-based activities to compare electrical utilization methods and optimize system performance.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE824.1	3	2	2	2	-	-	-	-	-	-	-	1	1	1
22EEE824.2	3	2	3	2	1	-	-	-	-	-	-	1	1	1
22EEE824.3	3	2	2	3	1	-	-	-	-	-	-	1	1	1
22EEE824.4	3	2	2	2	1	-	-	-	-	-	-	1	1	1
22EEE824.5	3	2	2	2	1	2	1	-	-	-	-	1	1	1
22EEE824.6	3	3	3	3	2	-	-	-	-	-	-	2	2	2

MODULE-1	**ELECTRIC HEATING & WELDING**	**22EEE824.1**	**8 Hours**
Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding - radiation welding			
Self-study	Electric welding practices		
Text Book	Text Book 1: 7.1, 7.2, 7.4, 7.5, 7.6,7.9,7.12 Text Book 2: 4.15,4.18		
MODULE-2	**ILLUMINATION**	**22EEE824.2**	**8 Hours**
Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED			
Applications	Applications in industries		
Text Book	Text Book 1: 1.1, 1.2, 1.3,1.4,1.5,1.5,1.6,1.7		
MODULE-3	**ELECTRIC DRIVES AND TRACTION**	**22EEE824.3**	**8 Hours**
Fundamentals of electric drive - choice of an electric motor - application of motors for particular services - traction motors - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear			
Case study	Energy consumption in Indian railways		
Text Book	Text Book 1: 6.1 ,6.2,6.3,6.4,6.5,6.6 Text Book 2: 1.4, 1.7		
MODULE-4	**REFRIGERATION AND AIR CONDITIONING**	**22EEE824.4**	**8 Hours**
Refrigeration Systems – Refrigerants – Types of Refrigeration Systems – Electrical Circuit of a Domestic Refrigerator – Trouble shooting of Refrigerator. Air Conditioning Systems – Types - Electrical circuit of window and Central Air Conditioning Systems			
Self-Study	Applications using different connection in three phase transformers.		
Text Book	Text Book 1: 4.1,4.2,4.3,4.4,4.5 Text Book 2: 1.12, 1.14		
MODULE-5	**ENERGY CONSERVATION AND STORAGE**	**22EEE824.5, 22EEE824.6**	**8 Hours**
Importance of energy conservation, Energy management techniques, General Comparison of Private Plant and Public Supply- Initial Cost and Efficiency, Capitalization of Losses, Choice of Voltage, Power Factor Improvement, Improvement of Load Factor, Energy storage systems – batteries, flywheels, supercapacitors.			
Self-study	Industrial energy conservation Techniques.		

Text Book	Text Book 1: 9.1, 9.2, 9.3, 9.4 Text Book 2: 1.18

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Utilization of Electrical Power, R.K.Rajput, Laxmi Publications Pvt. Ltd., Kolkata , 3rd Edition, 2023, ISBN: 978-81-318-0829-0
2) Generation, Distribution and Utilization of Electrical Energy, C. L. Wadhwa, New Age International, 4th Edition, 2017. ISBN-13: 978-9386418395

Reference Books:

1) Utilisation of Electric Power: Including Electric Drives and Electric Traction, N.V. Suryanarayana, New Age International Publishers, Second Edition, 2014, ISBN: 8122405460
2) Utilization of Electric Power and Electric Traction, J.B. Gupta, S.K.Kataria and Sons, Eleventh Edition 2015, ISBN :9350142589
3) Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009, ISBN :817371700

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/content/storage2/courses/108106022/LECTURE%201.pdf
- https://nptel.ac.in/courses/108105060
- https://archive.nptel.ac.in/content/storage2/courses/108105061/Illumination%20%20Engineering/Lesson-01/pdf

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

- Compare electric heating methods (resistance, arc, induction) using simulation tools like MATLAB/Simulink or real components.
- Choose suitable motors and control methods for speed/torque control
- Encourage Students to prepare a presentation on energy efficiency, speed control, and braking in traction systems.

SMART GRID TECHNOLOGIES

Course Code	**22EEE825**	**CIE Marks**	**50**
L: T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hours / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22EEE825.1	Understand smart grids and the smart grid policies and developments in smart grids.
22EEE825.2	Apply concepts of smart grid technologies in hybrid electrical vehicles.
22EEE825.3	Analyze the design and functionality of smart substations and feeder automation systems to enhance power distribution efficiency.
22EEE825.4	Analyze micro grids and distributed generation systems.
22EEE825.5	Evaluate the roles of stakeholders, market drivers, and technical challenges in smart grid adoption in electric vehicle integration
22EEE825.6	Compare grid performance for different operational scenarios

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE825.1	3	2	1	1	1	-	-	-	-	-	-	1	1	2
22EEE825.2	3	2	2	1	1	-	-	-	-	-	-	1	1	2
22EEE825.3	2	2	1	2	1	-	-	-	-	-	-	1	1	2
22EEE825.4	2	3	2	2	1	-	-	-	-	-	-	1	1	2
22EEE825.5	3	3	3	3	1	-	-	-	-	-	-	1	1	2
22EEE825.6	3	3	2	1	1	-	-	-	-	-	-	1	1	2

MODULE-1	**SMART GRID EVOLUTION**	**22EEE825.1**	**8 Hours**

Evolution of Indian Power Grid, Smart Grid-Definitions, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Drivers for SG in India, Challenges for SG, Difference between conventional & smart grid, Smart Grid Vision & Roadmap for India, Concept of Resilient and Self-Healing Grid, Present development & International policies of Smart Grid.

Functionalities and key components of smart grid. Smart grid Components for Transmission system, Smart grid components at distribution level, Architecture of smart grid, Pilot projects of Smart Grid in India.

Self-study	Functions of smart grid
Text Book	Text Book 1: 1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10,

MODULE-2	**SMART GRID TECHNOLOGIES**	**22EEE825.2, 22EEE825.3**	**8 Hours**

Introduction to Smart Meters, Advanced Metering Infrastructure, Distribution Automation, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid Technology (V2G), Smart Sensors, Smart Homes, Building Energy Management System

Substation Automation, Feeder Automation. Geographic Information System (GIS), Peak load Management, Energy Storage systems, Pumped hydro storage, CAES, FES, storage batteries, Thermal energy storage, Super capacitors.

Case study	Building Energy Management System
Text Book	Text Book 4: 2.1 to 3.1

MODULE-3	**MICROGRIDS**	**22EEE825.4**	**8 Hours**

Architecture and Layout of Microgrid, Types of Micro grid- DC Micro grid, AC Microgrid, Hybrid AC/DC Microgrid, Benefits of Distributed generation, Energy storage in Microgrids, Micro grid- Protection, Case studies of Micro grid in India.

Small scale distributed generation, Distributed Generation Resources-Fuel Cells, Solar Photovoltaic cells, Wind power, Fixed speed Wind Turbine generators, Variable speed wind turbine generators, Synchronous generator with In-line frequency control, Advantages of DG.

Case Study	DG integration into grid
Text Book	Text Book 3: 2.10 to 2.26, 2.48, 2.99

MODULE-4	**POWER QUALITY MANAGEMENT IN SMART GRID**	**22EEE825.4**	**8 Hours**

Power Quality-Basic definitions, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Power Quality Audit and its significance.

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi- Max based communication, Wireless Mesh Network, Broadband over Power line (BPL).

Case Study	Power Quality Audit
Text Book	Text Book 2: 2.9 to 3.9

MODULE-5	**SMART GRID MARKET DRIVERS**	**22EEE825.5 22EEE825.6**	**8 Hours**

Introduction – Comparison of Micro grid, power grid and Smart grid – Case study of STUXNET –Cyber security, Smart Grid Stake holders-Roles and Responsibilities, Technical challenges in SG Market operation. Electric Vehicle Technology, EV charging Infrastructure, EVSE Power standards, EVSE communication standards, Vehicle grid Integration (VGI), Challenges associated with VGI.	
Case Study	Electric Vehicle charging specifications with comparison
Text Book	Text Book 2: 1.2, 1.3, 1.6

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	10
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Smart grid Advance Technology and solution, Stuart Borlase, CRC Press, Second edition, Nov 2017, ISBN: 9781498799553.
2) Smart Grids: Clouds, Communications and Automation, Krzysztof Iniewski, David Bakken, Open Source, CRC Press, Taylor and Francis group, May 2014, ISBN: 9781315215525.
3) Microgrids and Active Distribution Networks, S. Chowdhury, S. P. Chowdhury, P. Crossley, Institution of Engineering and Technology, Jun 2009, ISBN: 1849190143.
4) Control and Automation of Electric Power Distribution Systems (Power Engineering), James Northcote, Green, Robert G. Wilson CRC Press, 2017, ISBN: 978-0824726317.

Reference Books:

1) Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities, Peter S. Fox Penner, Island Press; 1 edition, Jun 2010, ISBN: 1597267066.
2) Substation Automation systems Design and Implementation, Evelio Padilla Wiley Publishers, 2015, ISBN: 9781118987209.
3) Smart Grid: Fundamentals of design and analysis, James Momoh, John Wiley & sons Inc, IEEE press, 2015, ISBN: 978-1-118-15610-0.
4) Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, John Wiley & sons Inc, 2012, ISBN: 978-0-470-97409-4.
5) Smartgrid Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication, 2012, ISBN: 978-1-118-15610-0.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc23_ee60/preview
- https://www.smartgrid.gov/the_smart_grid/smart_grid.html
- https://indiasmartgrid.org/

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

- Video demonstration on smart grid technologies.
- Organizing group wise discussions on power quality management.
- Case study on vehicle to grid connection

INTERNSHIP

Course Code	**22EEE83**	**CIE Marks**	**100**
L: T:P:S	**0:0:10:0**	**SEE Marks**	**100**
Hrs / Week	**20**	**Total Marks**	**200**
Credits	**10**	**Exam Hours**	**03**

Course outcomes:
At the end of the Internship, the student will be able to:

22EEE83.1	Apply and validate fundamental theoretical knowledge by implementing it in projects undertaken within industry, startups, Centers of Excellence, or study centers
22EEE83.2	Cater to the recent industrial demands by analyzing and designing complex engineering solutions
22EEE83.3	Solve real life problems with the experience gained
22EEE83.4	Perform either as an individual or as a team to communicate the complex engineering activities with the community and with the society and comprehend the work through articles/reports

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22EEE83.1	3	3	3	3	3	3	2	1	3	3	3	3	2	3
22EEE83.2	3	3	3	3	3	3	2	1	3	3	3	3	2	3
22EEE83.3	3	3	3	3	3	3	2	1	3	3	3	3	2	3
22EEE83.4	3	3	3	3	3	3	2	1	3	3	3	3	2	3

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Internship.

Internship: The mandatory Internship is for **14 to 20 weeks**. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent SEE examination after satisfying the internship requirements. If the students are opting for the 8th semester, the following internship options are available:

- Industry Internship
- Research Internship
- Skill Enhancement Courses
- Post-Placement Training as Internship
- Online Internship

Industry internship: It is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints. Students undertaking industry internships must ensure the organization is listed on the VTU Internship Portal. If not, request the organization to register on the portal.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research. Research internships must be carried out in recognized research centers. Ensure that these centers are registered on the portal.

Skill Enhancement Courses: Students can take Skill-based courses with credits totalling the same as those of the internship. Students must be taken from registered providers listed on the VTU Internship Portal.

Post-Placement Training as Internship: The post-placement training is also considered an internship. For students placed during their 6th/7th semester and willing to take the training during their final year, colleges must inform the recruiting companies in advance to register on the VTU Internship Portal.

Online Internship: Reputed online internship platforms, including those identified by NSDC, are already listed on the VTU Internship portal. If colleges come across other eligible organizations not yet listed, they are informed to ask the organization to register on the VTU Internship portal.

CONTENTS	COS	Weeks
Perform a literature search to review current knowledge and developments in the chosen technical area in Industry. Review and finalization of the Approach to the Problem relating to the chosen topic/title. Preparation of work schedule	22EEE83.1	**3 -5**
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as required for the chosen field of Internship study	22EEE83.2	**3 -5**
Development of product/process, testing, results, conclusions and future directions as per industry needs/problems	22EEE83.3	**4-5**
Preparation of a Internship report/Presentations in the standard format for being evaluated by the guide and the department with certificate.	22EEE83.4	**4-5**

CIE Assessment Pattern (100 Marks)

RBT Levels		Marks Distribution	
		Review 1 (50 Marks)	**Review 2 (50 Marks)**
		50	**50**
L1	**Remember**	-	**-**
L2	**Understand**	**10**	**10**
L3	**Apply**	**10**	**10**
L4	**Analyze**	**10**	**10**
L5	**Evaluate**	**10**	**10**
L6	**Create**	**10**	**10**

SEE Assessment Pattern (100 Marks)

RBT Levels		Exam Marks Distribution (100)
L1	**Remember**	-
L2	**Understand**	20
L3	**Apply**	20
L4	**Analyze**	20
L5	**Evaluate**	20
L6	**Create**	20

INDIAN KNOWLEDGE SYSTEMS

Course Code	**22IKK84**	**CIE Marks**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**1**	**Total Marks**	**50**
Credits	**0**	**Exam Hours**	**--**

Course outcomes:

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

22IKK84.1	Provide an overview of the concept of the Indian Knowledge System and its importance.
22IKK84.2	Appreciate the need and importance of protecting traditional knowledge.
22IKK84.3	Recognize the relevance of Traditional knowledge in different domains.
22IKK84.4	Establish the significance of Indian Knowledge systems in the contemporary world.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
22IKK84.1	2	-	-	-	-	-	-	3	-	-	-	1
22IKK84.2	-	-	-	-	-	2	-	-	-	-	-	-
22IKK84.3	-	-	2	2	-	-	-	-	-	-	-	-
22IKK84.4	-	-	-	-	-	3	2	-	-	-	-	-

MODULE-1	**INTRODUCTION TO INDIAN KNOWLEDGE SYSTEMS (IKS)**	**22IKK84.1, 22IKK84.2**	**5 Hours**

Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.

MODULE-2	**TRADITIONAL KNOWLEDGE IN PROFESSIONAL DOMAIN**	**22IKK84.3**	**5 Hours**

Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Dyes and painting technology, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.

MODULE- 3	**TRADITIONAL KNOWLEDGE IN GOVERNANCE AND ECONOMICS**	**22IKK84.4**	**5 Hours**

Governance and public administration, United Nations Sustainable development goals, an overview of Indian economic thought–Arthasastra and Nitisastra, Leadership and Motivation, Planning and Organizing, Financial Management

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Test (s) (MCQs)	AAT
		25	**25**
L1	**Remember**	**5**	**5**
L2	**Understand**	**5**	**5**
L3	**Apply**	5	5
L4	**Analyze**	**5**	5
L5	**Evaluate**	**5**	**5**
L6	**Create**	**-**	**-**

Suggested Learning Resources:

Reference Books:

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

Web links and Video Lectures (e-Resources):

1. https://iksindia.org/lectures-and-videos.php
2. http://nptel.ac.in/courses/121106003/
3. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf

4. https://www.youtube.com/watch?v=LZP1StpYEPM

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

- Reflection and Discussion
- Case Studies

APPENDIX A

List of Assessment patterns

1. Assignment
2. Group Discussions
3. Case studies
4. Practical Orientation on design thinking, Creative & Innovation
5. Participatory & Industry-Integrated Learning
6. Practical Activities/Problem Solving Exercises
7. Class Presentations
8. Analysis of Industry/Technical/Business Reports
9. Reports on Industrial Visits
10. Industrial/Social/Rural Projects
11. Participation in External Seminars/Workshops
12. Online/Offline Quizzes

APPENDIX B

Outcome Based Education

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

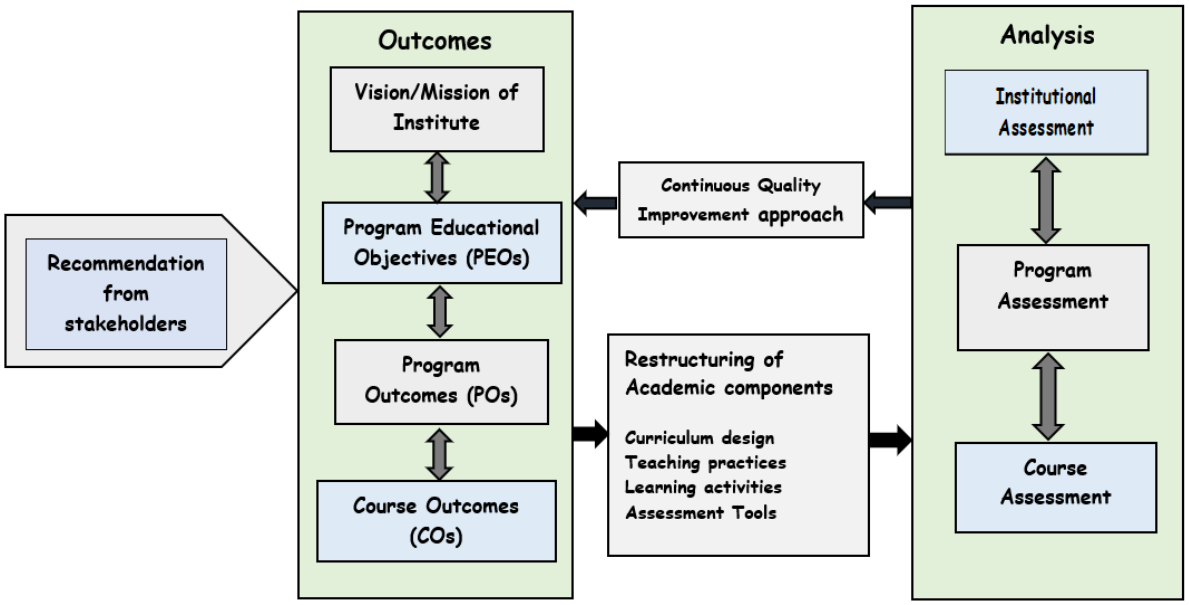
There are three educational Outcomes as defined by the National Board of Accreditation:

Program Educational Objectives: The Educational objectives of engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation.

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

Mapping of Outcomes



APPENDIX C

The Graduate Attributes of NBA

Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Conduct investigations of complex problems: The problems that cannot be solved by straight forward application of knowledge, theories and techniques applicable to the engineering discipline. * That may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement. (like: cost, power requirement, durability, product life, etc.).,which need to be defined (modeled) within appropriate mathematical framework that often require use of modern computational concepts and tools.

Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective

presentations, and give and receive clear instructions.

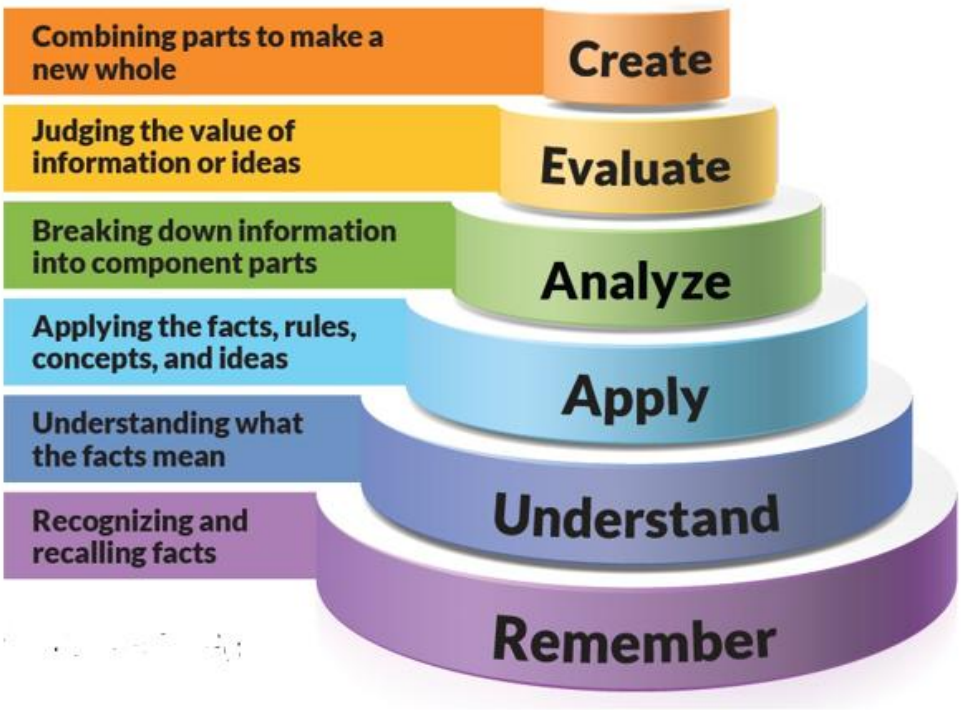
Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

APPENDIX D

BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies.



www.newhorizonindia.edu
Ring Road, Bellandur Post,
Near Marathahalli, Bengaluru,
Karnataka 560103, India.

FOLLOW US