INSTITUTE OF ENGINEERING & MANAGEMENT

An Autonomous Institution, Affiliated to MAKAUT

DEPARTMENT OF ELECTRICAL ENGINEERING

SEMESTER WISE CURRICULAM

4th YEAR- 8th SEMESTER

Syllabus for B. Tech Admission Batch 2022

Semester VIII [Fourth year]
Branch/Course: Electrical Engineering
Course structure

Sl No	Type of Course	Course Code	Course Name	L	T	P	S	Total Contact Hours	Credit Points
Theory									
1	Professional Elective Courses	PEC-EE801	A. Control System Design B. Electrical Energy Conservation and Audit C. Electrical Machine Design	3	0	0	0	3	3
2	Professional Elective Courses	PEC-EE802	A. H.V.D.C. Transmission System B. Power quality & FACTS C. Power System Protection	3	0	0	0	3	3
3	Open Elective Courses	OEC-EE801	A. Power Plant Engineering B. Automobile Engineering C. Sensors & Transducers	3	0	0	0	3	3
4	Humanities and social sciences including Management	ESPEE 801	Essential Studies for Professionals VIII	2	0	0	0	2	0.5
SESSIONAL									
5	Project. Seminar and Industrial Training	PI 881	Industrial Training/Internship				12w	-	4
6	Humanities and social sciences including Management	SDP 881	Skill Development for Professionals VII				2	2	0.5
7	Project. Seminar and Industrial Training	PWEE881	Project (Phase II)				6	6	3
Value Added Courses									
8	Massive Open Online Courses (MOOCs)	MOOCs	Massive Open Online Courses (MOOCs)						
9	Industry and Foreign Certification (IFC)	IFC	Industry and Foreign Certification (IFC)						
10	Mandatory Additional Requirements (MAR)	MAR781	Mandatory Additional Requirements (MAR)						
Total Credit Points of Semester									**17**

Subject Name: Control Systems Design
Subject Code: PEC-EE 801A
Pre-requisite: Control Systems, Mathematics

Credit: 3
Lecture Hours: 39

Course Objective:

The purpose of learning this course is

1. Design control systems according to time domain specifications.
2. Design control systems according to frequency domain specifications.
3. Understand nonlinear dynamical systems modeling and analysis by linearization.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand various design specifications.
2. Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).
3. Design controllers using the state-space approach.
4. Understand the significance of nonlinearities in systems modeling and analysis.

Detailed Syllabus

Module No	Topic	Mapping with Industry and International Academia	Lecture Hours	Textbook	Mapped Chapters
1	**Design Specifications** Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.	***AICTE-prescribed syllabus:*** (AICTE Syllabus **NPTEL:** https://nptel.ac.in/courses/107106081 ***Industry Mapping:*** MATLAB	**6**	N. Nise, "Control Systems Engineering"	9, 11
2	**Design of Classical Control System in the time domain** Introduction to compensators. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.	***AICTE-prescribed syllabus:*** (AICTE Syllabus **NPTEL:** https://nptel.ac.in/courses/107106081 ***Industry Mapping:*** MATLAB	**8**	N. Nise, "Control Systems Engineering"	9
3	**Design of Classical Control System in frequency domain:** Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using Bode diagram.	***AICTE-prescribed syllabus:*** (AICTE Syllabus **NPTEL:** https://nptel.ac.in/courses/107106081 ***Industry Mapping:*** MATLAB	**8**	N. Nise, "Control Systems Engineering"	11
4	**Design of PID controllers** Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.	***AICTE-prescribed syllabus:*** (AICTE Syllabus **NPTEL:** https://nptel.ac.in/courses/1	**6**	N. Nise, "Control Systems Engineering	9, 11

		07106081 ***Industry Mapping:*** MATLAB		”	
5	**Control System Design in state space** Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman’s Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.	***AICTE-prescribed syllabus:*** (AICTE Syllabus **NPTEL:** https://nptel.ac.in/courses/107106081 ***Industry Mapping:*** MATLAB	**8**	N. Nise, “Control Systems Engineering ”	12
6	**Nonlinearities and its effect on system performance** Various types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.	***AICTE-prescribed syllabus:*** (AICTE Syllabus **NPTEL:** https://nptel.ac.in/courses/107106081 ***Industry Mapping:*** MATLAB	**3**	N. Nise, “Control Systems Engineering ”	2, 3

Lession Plan:

Day	Description
1	Introduction to design problem and philosophy.
2-3	Introduction to time domain and frequency domain design specifications and their physical relevance.
4	Effect of gain on transient and steady state response.
5	Effect of addition of pole on system performance.
6	Effect of addition of zero on system performance.
7	Introduction to compensators.

8-10	Design of Lag, lead lag-lead compensator in time domain.
11-12	Feedback and Feed forward compensator design.
13-14	Feedback compensation. Realization of compensators.
15-18	Compensator design in frequency domain to improve steady state and transient response.
19-22	Feedback and Feed forward compensator design using Bode diagram.
23-26	Design of P/PI/PD/PID controllers in time domain and frequency domain for $1^{st}/2^{nd}/3^{rd}$ order systems.
27-28	Control loop with auxiliary feedback – Feed forward control.
29-30	Review of state space representation.
31	Concept of controllability & observability.
32	Effect of pole zero cancellation on the controllability & observability of the system.
33	Pole placement design through state feedback.
34	Ackerman's Formula for feedback gain design. Design of Observer.
35-36	Reduced order observer. Separation Principle.
37-38	Various types of non-linearities. Effect of various non-linearities on system performance. Singular points.
39	Phase plot analysis.

Suggested Learning Resources:

Textbooks

1. N. Nise, "Control Systems Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control System Engineering", Wiley, 2000.

Reference Books

1. M. Gopal, “Digital Control Engineering”, Wiley Eastern, 1988.
2. K. Ogata, “Modern Control Engineering”, Prentice Hall, 2010.
3. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.
4. J. J. D’Azzo and C. H. Houpis, “Linear control system analysis and design (conventional and modern)”, McGraw Hill, 1995.
5. R. T. Stefani and G. H. Hostetter, “Design of feedback Control Systems”, Saunders College Pub, 1994.

CO-PO mapping

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

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Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: Electrical Energy Conservation and Audit **Credit: 3**

Subject Code: PEC-EE801B **Lecture Hours: 40**

Pre-requisite: Electrical Machines I & II, Power Systems I & II

Relevant Links:

1. Link for Study Material: Energy Conservation and audit.pdf

2. Link for NPTEL Course: **Link**

Course Objective:

The purpose of learning this course is-

1. To understand the current energy scenario and importance of energy conservation.
2. To understand the concepts of energy management.
3. To understand the methods of improving energy efficiency in different electrical systems.
4. To understand the concepts of different energy efficient devices.

Course Outcome:

At the end of this course, students will demonstrate the ability to

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the concepts of different energy efficient devices.

Detailed Syllabus:

Module number	Topic	Mapping with Industry and International Academia	Lecture Hours	Text Book	Mapped Chapter
1	**Energy Scenario:** Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features	**International Academia:** MIT Mapped Syllabus **AICTE-prescribed syllabus**: Aicte syllabus **Industry Mapping:** Energy Conservation Act, 2001	**6**	S. C. Tripathy, "Utilization of Electrical Energy and Conservation"	**1**

2	**Basics of Energy and its various forms** Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.	**International Academia:** MIT Mapped Syllabus **AICTE-prescribed syllabus**: Aicte syllabus **Industry Mapping:** Energy Conservation Act, 2001	**8**	S. C. Tripathy, "Utilization of Electrical Energy and Conservation"	**2**
3	**Energy Management & Audit** Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	**International Academia:** MIT Mapped Syllabus **AICTE-prescribed syllabus**: Aicte syllabus **Industry Mapping:** Energy Conservation Act, 2001	**6**	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects	**1**
4	**Energy Efficiency in Electrical Systems** Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.	**International Academia:** MIT Mapped Syllabus **AICTE-prescribed syllabus**: Aicte syllabus **Industry Mapping:** Energy Conservation Act, 2001	**7**	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects	3

5	**Energy Efficiency in Industrial Systems** Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.	**International Academia:** MIT Mapped Syllabus **AICTE-prescribed syllabus**: Aicte syllabus **Industry Mapping:** Energy Conservation Act, 2001	**8**	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects	4
6	**Energy Efficient Technologies in Electrical Systems** Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology	**International Academia:** MIT Mapped Syllabus **AICTE-prescribed syllabus**: Aicte syllabus **Industry Mapping:** Energy Conservation Act, 2001	**8**	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects	4

Lesson Plan:

Module :

DAY	LESSON PLAN – DESCRIPTION
1	**Energy Scenario:** Commercial and Non-commercial energy, primary energy resources,
2	commercial energy production, final energy consumption, energy needs of growing economy,
3	long term energy scenario, energy pricing
4	energy sector reforms, energy and environment, energy security,..

5	energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change
6	Energy Conservation Act-2001 and its features
7	**Basics of Energy and its various forms** Electricity tariff, , power factor improvement
8	load management and maximum demand control
9	selection & location of capacitors
10	Thermal Basics-fuels, thermal energy contents of fuel
11	Thermal Basics- temperature & pressure, heat capacity
12	Thermal Basics- sensible and latent heat, evaporation, condensation
13	Thermal Basics- steam, moist air and humidity & heat transfer, units and conversion
14	**Energy Management & Audit** Definition, energy audit, need, types of energy audit.
15	Energy management (audit) approach understanding energy costs, bench marking, energy performance, ,
16	matching energy use to requirement, maximizing system efficiencies
17	optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.
18	Material and Energy balance: Facility as an energy system, methods for preparing process flow
19	material and energy balance diagrams
20	**Energy Efficiency in Electrical Systems** Electrical system: Electricity billing, electrical load management and maximum demand control
21	power factor improvement and its benefit
22	selection and location of capacitors
23	performance assessment of PF capacitors, distribution and transformer losses.
24	Electric motors: Types, losses in induction motors, motor efficiency,
25	Electric motors: factors affecting motor performance, rewinding and motor replacement issues,
26	Electric motors: energy saving opportunities with energy efficient motors.
27	**Energy Efficiency in Industrial Systems** Compressed Air System: Types of air compressors
28	compressor efficiency, efficient compressor operation
29	Compressed air system components, capacity assessment, leakage test
30	factors affecting the performance and savings opportunities in HVAC
31	Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

32	Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities
33	Cooling Tower: Types and performance evaluation, efficient system operation,
34	Cooling Tower: flow control strategies and energy saving opportunities, assessment of cooling towers.
35	**Energy Efficient Technologies in Electrical Systems** Maximum demand controllers, automatic power factor controllers
36	energy efficient motors
37	soft starters with energy saver
38	variable speed drives, energy efficient transformers
39	electronic ballast, occupancy sensors
40	energy efficient lighting controls, energy saving potential of each technology

Text Books:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
2. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.

Reference Books:

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	3		2					1
CO2	3	3	2	2	2	2					1
CO3	3	3	3	2	1						1
CO4	3	1	1	2							1

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Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: Electrical Machine Design **Credit: 3**
Subject Code: PEC-EE801C **Lecture Hours: 40**

Electrical Machine I, Electrical Machine II

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the construction and performance characteristics of electrical machines.
2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
3. Understand the principles of electrical machine design and carry out a basic design of an ac machine.
4. Use software tools to do design calculations.

Course Outcomes: At the end of this course, students will demonstrate the ability to

CO1: Design of Transformer
CO2: Design of Induction Motor
CO3: Design of Synchronous Machine
CO4: Design of Machines using AutoCAD software

Detailed Syllabus

Module No	Description	Lecture Hours	Mapping with Industry and International Academia	Text Book	Mapped Chapter
1	**Introduction** Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.	5	**Industry Mapping:** CAD, SolidWorks **International Academia:** MIT Mapped	A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.	4
2	**Transformers** Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.	8	**Industry Mapping:** CAD, SolidWorks **International Academia:** MIT Mapped	A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.	7
3	**Induction Motors** Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.	10	**Industry Mapping:** CAD, SolidWorks **International Academia:** MIT Mapped	A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.	10
4	**Synchronous Machines** Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio,	10	**Industry Mapping:** CAD, SolidWorks **International Academia:**	A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and	12

	shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.		MIT Mapped	Sons, 1970.	
5	**Computer aided Design (CAD):** Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.	**7**	**Industry Mapping:** CAD, SolidWorks **International Academia:** MIT Mapped	A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.	**16**

Suggested Learning Resources:

Relevant Links:

Study Material

Text Books

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", Satya Prakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979.
6. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

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Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: H.V.D.C. Transmission System **Credit: 3**
Subject Code: PEC-EE802A **Lecture Hours: 40**
Pre-requisite: Power System Engineering, Power Electronics

Relevant Links

Study Material : hvdc presentation.pdf NPTEL Link

Course Objective(s):

The purpose of learning this course is-

1. To understand the advantages of dc transmission over ac transmission.
2. To understand the operation of Line Commutated Converters and Voltage Source Converters.
3. To realize the control strategies used in HVdc transmission system
4. To understand the monitoring and control of a power system.
5. To understand the improvement of power system stability using an HVdc system.

Course Outcome:

At the end of this course, students will demonstrate the ability to

CO1. Understand the advantages of dc transmission over ac transmission and components of HVdc system.
CO2. Realize the operation of Line Commutated Converters and Voltage Source Converters.
CO3. Understand and analyze the control strategies used in HVdc transmission system.
CO4. Understand the application of MTDC links and appreciate the improvement of power system stability using an HVdc system.

Detailed Syllabus

Module number	Topic	Mapping with Industry and International Academia	Lecture Hours	Text Book	Mapped Chapter
1	**DC Transmission Technology:** Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVdc Systems. Components of a HVDC system. Line Commutated Converter and Voltage Source Converter based systems.	Industry Mapping: MATLAB, ETAP. International Academia: https://www.mitsubishielectric.com/eig/energysystems/products/transmission/pss/hvdc/	4	S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2014	1
2	**Analysis of Line Commutated and Voltage Source Converters:** Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.	Industry Mapping: MATLAB, ETAP. International Academia: https://onlinecourses.nptel.ac.in/noc20_ee09/preview	10	S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2014	2,3
3	**Control of HVdc Converters:** Principles of Link Control in a LCC-HVdc system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC-HVdc system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.	Industry Mapping: MATLAB, ETAP. International Academia: https://dspace.mit.edu/handle/1721.1/150462	10	S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2014	4,5

4	**Components of HVdc systems:** Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.	Industry Mapping: MATLAB, ETAP. International Academia: https://www.mitsubishielectric.com/eig/energysystems/products/transmission/pss/hvdc/	**8**	S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2014	6,7,8
5	**Stability Enhancement using HVdc Control: Basic Concepts:** Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.	Industry Mapping: MATLAB, ETAP.	**4**	S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2014	11
6	**MTdc Links:** Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVdcTechnology. Introduction to Modular Multi-level Converters.	Industry Mapping: MATLAB, ETAP. International Academia: https://www.mitsubishielectric.com/eig/energysystems/products/transmission/pss/hvdc/	**4**	S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2014	10

Suggested Learning Resources:

Text Books

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2014.

Reference books:

1. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
2. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

CO-PO mapping

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

Course Plan:

SL. No.	DAY	MODULE	TOPIC
1	**1**	**I**	Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability).
2	**2**		Application of DC Transmission. Types of HVdc Systems
3	**3**		Components of a HVDC system.
4	**4**		Line Commutated Converter and Voltage Source Converter based systems.
5	**5**	**II**	Line Commutated Converters (LCCs)
6	**6**		Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters.
7	**7**		Inverter Operation
8	**8**		Effect of Commutation Overlap.
9	**9**		Expressions for average dc voltage, AC current and reactive power absorbed by the converters.
10	**10**		Effect of Commutation Failure, Misfire and Current Extinction in LCC links.
11	**11**		Two and Three-level VSCs.
12	**12**		PWM schemes
13	**13**		Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation.
14	**14**		Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.
15	**15**	**III**	Principles of Link Control in a LCCHVdc system

16	**16**		Control Hierarchy, Firing Angle Controls
17	**17**		Phase-Locked Loop
18	**18**		Current and Extinction Angle Control
19	**19**		Starting and Stopping of a Link
20	**20**		Higher level Controllers Power control, Frequency Control, Stability Controllers
21	**21**		Reactive Power Control.
22	**22**		Principles of Link Control in a VSC HVdc system
23	**23**		Power flow and dc Voltage Control.
24	**24**		Reactive Power Control/AC voltage regulation.
25	**25**	**IV**	Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line
26	**26**		Corona Effects. Insulators
27	**27**		Transient Over-voltages
28	**28**		dc line faults in LCC systems
29	**29**		dc line faults in VSC systems
30	**30**		dc breakers
31	**31**		HVDC link & Operation
32	**32**		Ground Electrodes
33	**33**	**V**	Basic Concepts: Power System Angular, Voltage and Frequency Stability
34	**34**		Power Modulation: basic principles
35	**35**		synchronous and asynchronous links
36	**36**		Voltage Stability Problem in AC/dc systems.
38	**38**	**VI**	Multi-Terminal and Multi-Infeed Systems.
39	**39**		Series and Parallel MTdc systems using LCCs.
40	**40**		MTdc systems using VSCs. Modern Trends in HVdcTechnology
40	**40**		Introduction to Modular Multi-level Converters.

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Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: Power quality & FACTS **Credit: 3**

Subject Code: PEC-EE802 B **Lecture Hours: 40**

Pre-requisite: Power System-I, Power System-II, Power Electronics

Course Objective:

The purpose of learning this course is-

1. To understand the effect of power quality problems in power system .
2. To understand the transient and steady-state response of electrical circuits.
3. To analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
4. To analyse two port circuit behavior.

Course Outcome:

At the end of this course, students will demonstrate the ability to

CO1. Apply network theorems for the analysis of electrical circuits.
CO2. Obtain the transient and steady-state response of electrical circuits.
CO3. Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
CO4. Analyse two port circuit behavior.

Relevant Links:

Study Material **NPTEL Link1 , NPTEL Link 2** LinkedIn Learning

Detailed Syllabus:

Module number	Topic	Mapping with Industry and International Academia	Lecture Hours	Text Book	Mapped Chapter
1	**Transmission Lines and Series/Shunt Reactive Power Compensation** Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.	Industry Mapping: MATLAB, ETAP. International Academia: https://ocw.mit.edu/courses/ids-505j-engineering-economics-and-regulation-of-the-electric-power-sector-spring-2010/	**4**	Power system harmonic analysis, Jos Arrillaga, Bruce C Smith Neville R Watson, Alan R Wood, JOHN WILEY & SONS	**3**
2	**Thyristor-based Flexible AC Transmission Controllers (FACTS)** Description and Characteristics of Thyristor-based FACTS devices:Static VAR Compensator(SVC), Thyristor Controlled Series Capacitor(TCSC) ,Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.	Industry Mapping: MATLAB, ETAP. International Academia: https://ocw.mit.edu/courses/6-691-seminar-in-electric-power-systems-spring-2006/	**8**	FACTS Devices and Power Transmission, Mr. Rohit Manglik, EduGorilla Publication	**3**

3	**Voltage Source Converter based (FACTS) controllers** Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator .Fault Current Limiter.	Industry Mapping: MATLAB, ETAP. International Academia: https://ocw.mit.edu/courses/6-691-seminar-in-electric-power-systems-spring-2006/	**10**	FACTS Devices and Power Transmission, Mr. Rohit Manglik, EduGorilla Publication	8
4	**Application of FACTS** Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.	Industry Mapping: MATLAB, ETAP. International Academia: https://ocw.mit.edu/courses/6-691-seminar-in-electric-power-systems-spring-2006/	**6**	FACTS Devices and Power Transmission, Mr. Rohit Manglik, EduGorilla Publication	5
5	**Power Quality Problems in Distribution Systems** Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.	Industry Mapping: MATLAB, ETAP. International Academia: https://ocw.mit.edu/courses/ids-505j-engineering-economics-and-regulation-of-the-electric-power-sector-spring-2010/	**6**	Power system harmonic analysis, Jos Arrillaga, Bruce C Smith Neville R Watson, Alan R Wood, JOHN WILEY & SONS	9
6	**Dynamic Voltage Restorer and Unified Power Quality Conditioner** Voltage Sag/Swell mitigation: DynamicVoltageRestorer–Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC):Working Principle.Capabilities and Control Strategies.	Industry Mapping: MATLAB, ETAP. International Academia: https://ocw.mit.edu/courses/ids-505j-engineering-economics-and-regulation-of-the-electric-power-sector-spring-2010/	**6**	Power system harmonic analysis, Jos Arrillaga, Bruce C Smith Neville R Watson, Alan R Wood, JOHN WILEY & SONS	**8**

Lesson Plan:

DAY	LESSON PLAN – DESCRIPTION
1	Basics of AC Transmission. Analysis of uncompensated AC transmission lines..
2	Passive Reactive Power Compensation
3	Shunt and series compensation at the mid-point of an AC line.
4	Comparison of Series and Shunt Compensation.
5	Description and Characteristics of Thyristor-based FACTS devices Fault Current Limiter.
6	Static VAR Compensator(SVC)
7	Thyristor Controlled Series Capacitor(TCSC)
8	Single Pole Single Throw (SPST) Switch.
9	Configurations/Modes of Operation
10	Harmonics and control of SVC
11	Thyristor Controlled Braking Resistor
12	Harmonics and control of TCSC
13	Voltage Source Converters (VSC): Six Pulse VSC.
14	GTO Controlled Series Compensator
15	Multi-pulse and Multi-level Converters
16	Pulse-Width Modulation for VSCs.
17	Selective Harmonic Elimination
18	Sinusoidal PWM and Space Vector Modulation.
19	STATCOM: Principle of Operation
20	Reactive Power Control: Type I and Type II controllers
21	Static Synchronous Series Compensator (SSSC)
22	Unified Power Flow Controller (UPFC): Principle of Operation.
23	Unified Power Flow Controller (UPFC): Principle of Control.
24	Working principle of Interphase Power Flow Controller
25	Fault Current Limiter.
26	Application of FACTS devices for power-flow control and stability improvement..
27	Simulation example of power swing damping in a single-machine infinite bus system using a TCSC.
28	Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM
29	Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency.

30	Unbalance, Sags, Swells, Interruptions, ,...
31	Wave-form Distortions: harmonics, noise, notching
32	dc-offsets, fluctuations
33	Flicker and its measurement
34	Tolerance of Equipment: CBEMA curve
35	Voltage Sag/Swell mitigation:..
36	DynamicVoltageRestorer–Working Principle
37	Series Active Filtering
38	Unified Power Quality Conditioner (UPQC): Working Principle.
39	DynamicVoltageRestorer–Control Strategies.
40	Unified Power Quality Conditioner (UPQC): Working Capabilities and Control Strategies

Text Books:

1. Power system harmonic analysis, Jos Arrillaga, Bruce C Smith Neville R Watson, Alan R Wood, JOHN WILEY & SONS

2. FACTS Devices and Power Transmission, Mr. Rohit Manglik, EduGorilla Publication

Reference Books:

1. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
3. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

CO-PO mapping

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

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Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: Power System Protection **Credit: 3**
Subject Code: PEC-EE802 C **Lecture Hours: 40**
Pre-requisite: Power System-I, Power System-II

Relevant Links

Study Material: Power system protection Protection_paithankar.pdf

NPTEL: Power System Protection - Course https://nptel.ac.in/courses/108105167

Course Objective(s):

The purpose of learning this course is-

1. To understand the different protection components in power system.
2. To study and analyse the effect fault and overcurrent protection in power system.
3. To understand the applications of different protection schemes and its improvement using WAMS.
4. To analyse the effect of transients and ways of mitigating it.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1. Understand the different components of a protection system.
CO2. Evaluate fault current due to different types of fault in a network.
CO3. Understand the protection schemes for different power system components and the use of wide-area measurements.
CO4. Understand the basic principles of digital protection.

Detailed Syllabus

Module number	Topic	Mapping with Industry and International Academia	Lecture Hours	Text Book	Mapped Chapter
1	Introduction and Components of a Protection System: Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers.	Industry Mapping: MATLAB, ETAP. International Academia: Introduction to Electric Power Systems | Electrical Engineering and Computer Science | MIT OpenCourseWare	**4**	Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.	1
2	Faults and Over-Current Protection: Review of Fault Analysis, Sequence Networks. Introduction to Overcurrent Protection and overcurrent relay co-ordination.	Industry Mapping: MATLAB, ETAP. International Academia: Introduction to Electric Power Systems | Electrical Engineering and Computer Science | MIT OpenCourseWare	**8**	Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.	2
3	Equipment Protection Schemes: Directional, Distance, Differential protection. Transformer and Generator protection. Bus bar Protection, Bus Bar arrangement schemes.	Industry Mapping: MATLAB, ETAP. International Academia: Introduction to Electric Power Systems | Electrical Engineering and Computer Science | MIT OpenCourseWare	**8**	Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.	3,4,6,8

4	Digital Protection: Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues.	Industry Mapping: MATLAB, ETAP. International Academia: Introduction to Electric Power Systems | Electrical Engineering and Computer Science | MIT OpenCourseWare	**8**	Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.	7
5	Modeling and Simulation of Protection Schemes: CT/PT modeling and standards, Simulation of transients using Electro-Magnetic Transients (EMT) programs. Relay Testing.	Industry Mapping: MATLAB, ETAP. International Academia: Introduction to Electric Power Systems | Electrical Engineering and Computer Science | MIT OpenCourseWare	**8**	Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.	5
6	System Protection: Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.	Industry Mapping: MATLAB, ETAP. International Academia: Introduction to Electric Power Systems | Electrical Engineering and Computer Science | MIT OpenCourseWare	**4**	Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.	11

Suggested Learning Resources:

Text Books

1. Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.
2. A. G. Phadke and J. S. Thorp, "Relaying for Power Systems", John Wiley & Sons, 1988.

Reference Books

1. J. L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 1987.
2. A. G. Phadke and J. S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer, 2008.
3. D. Reimert, "Protective Relaying for Power Generation Systems", Taylor and Francis, 2006.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO10
CO1	3	1	1	0	1	0	0	0	0	0	0
CO2	3	3	3	3	3	2	0	0	0	0	1
CO3	3	1	2	0	1	0	0	0	0	0	1
CO4	3	3	3	3	2	1	0	0	0	0	1

Lesson Plan:

DAY	MODULE	TOPIC
1	**1**	Principles of Power System Protection
2		Relays
3		Instrument transformers
4		Circuit Breakers
5	**2**	Faults and Over-Current Protection
6		Review of Fault Analysis,
7		Sequence Networks
8		Introduction to Overcurrent Protection
9		Application of Definite Time OC Relays
10		Inverse Time Over-Current Relay
11		Protection of a Three-phase Feeder
12		overcurrent relay co-ordination
13	**3**	Equipment Protection Schemes:
14		Directional protection
15		Distance protection
16		Differential protection.
17		Transformer protection
18		Generator protection
19		Bus bar Protection

20		Bus Bar arrangement schemes
21	**4**	Digital Protection
22		Computer-aided protection
23		Fourier analysis
24		Estimation of Phasors from DFT
25		Sampling, aliasing issues
26		Three-stepped Distance Protection
27		Block Diagram of Numerical Relay
28		Least Error Squared (LES) Technique
29	**5**	Modeling and Simulation of Protection Schemes
30		CT/PT modeling and standards
31		Simulation of transients using Electro-Magnetic Transients (EMT) programs.
32		Relay Testing
33		Selection of CT Ratios in Case of Busbar Protection
34		Circuit Model of Saturated CT
35		Stability Ratio of High Impedance Busbar Differential Scheme
36		Supervisory Relay
38	**6**	Effect of Power Swings on Distance Relaying. System Protection Schemes.
39		Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors
40		Phasor Measurement Units and Wide-Area Measurement Systems (WAMS)
40		Application of WAMS for improving protection systems.

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Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: Power Plant Engineering **Credit: 3**

Subject Code: OEC-EE801A **Lecture Hours: 40**

Pre-requisite: Electrical Machines I & II, Power Systems I & II

Course Objective:

The purpose of learning this course is-

1. To understand methods of selection of power plant and its economics.
2. To understand the principle of operation different types of power plants.
3. To understand methods of site selection of different power plants.
4. To solve numerical problems of load estimation, economics of power plants.

Course Outcome:

At the end of this course, students will demonstrate the ability to

CO1. Explain the principle of operation of Steam, Hydroelectric, Diesel, Gas turbine, Nuclear power and non-conventional power plant.

CO2. Identify the cause of pollution for power generation and its remedy.

CO3. Suggest location to set up and methods of maintenance Steam, Hydroelectric, Diesel, Gas turbine and Nuclear power plant.

CO4. Solve numerical problems of load estimation and economics of power plants.

Relevant Links:

Study Material **NPTEL Link**

Detailed Syllabus:

Module number	Topic	Mapping with Industry and International Academia	Lecture Hours	Text Book	Mapped Chapter
1	**Introduction:** Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant. Power plant economics and selection: Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.	**International Academia:** https://www.academia.edu/41215353/Power_Plant_Engineering. **AICTE-prescribed syllabus:** AICTE Syllabus **Industry Mapping:** Energy Conservation Act, 2001 (amended in 2010 and 2022) of India.	**8**	P.K. Nag, "Power Plant Engineering", Tata McGraw Hill.	**1**

2	**Steam power plant:** General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.	**International Academia:** https://www.academia.edu/41215353/Power_Plant_Engineering. **AICTE-prescribed syllabus:** AICTE Syllabus **Industry Mapping:** Energy Conservation Act, 2001 (amended in 2010 and 2022) of India.	**8**	P.K. Nag, "Power Plant Engineering", Tata McGraw Hill.	**2,4**
3	**Diesel power plant** General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant. **Gas turbine power plant:** Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant.	**International Academia:** https://www.academia.edu/41215353/Power_Plant_Engineering. **AICTE-prescribed syllabus:** AICTE Syllabus **Industry Mapping:** Energy Conservation Act, 2001 (amended in 2010 and 2022) of India.	**8**	P.K. Nag, "Power Plant Engineering", Tata McGraw Hill.	**3,11**

4	**Nuclear power plant:** Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants. Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems. **Non Conventional Power Plants:** Introduction to non-conventional power plants (Solar, wind, geothermal, tidal).	**International Academia:** https://www.academia.edu/41215353/Power_Plant_Engineering. **AICTE-prescribed syllabus:** AICTE Syllabus **Industry Mapping:** Energy Conservation Act, 2001 (amended in 2010 and 2022) of India.	**9**	P.K. Nag, "Power Plant Engineering", Tata McGraw Hill.	**9, 13**
5	**Electrical system:** Generators and their cooling, transformers and their cooling. Instrumentation Purpose, classification, selection and application, recorders and their use, listing of various control rooms. Pollution due to power generation.	**International Academia:** https://www.academia.edu/41215353/Power_Plant_Engineering. **AICTE-prescribed syllabus:** AICTE Syllabus **Industry Mapping:** Energy Conservation Act, 2001 (amended in 2010 and 2022) of India.	**7**	P.K. Nag, "Power Plant Engineering", Tata McGraw Hill.	..

Lesson Plan:

Day	Topic / Description
1	Introduction to Power and Energy – Definition, sources of energy, conventional and non-conventional energy resources.
2–3	Review of Thermodynamic Cycles – Rankine, Brayton, Otto and Diesel cycles; relevance to power plant operation and efficiency.
4	Fuels and Combustion – Types of fuels, combustion equations, calorific value, air-fuel ratio calculations.
5–6	Load Estimation and Load Curves – Load factor, diversity factor, demand factor, connected load; daily and annual load curves.
7	Variable Load on Power Plant Operation – Impact on efficiency, fuel consumption, and maintenance.
8	Selection of Power Plant – Criteria for selection based on location, load demand, cost, and availability of resources.
9–10	Power Plant Economics and Cost Analysis – Fixed, operating, and fuel costs; cost per kWh; tariff structures.
11–12	Depreciation and Replacement Theory – Methods of depreciation; economic life of power plants; rate of return and profit factors.
13–14	Economics of Plant Selection – Comparative study of different power plants; effect of type on costs and efficiency.
15–16	Steam Power Plant – General Layout and Operation – Major components and flow diagram of modern steam plant.
17–18	Boilers and Accessories – High-pressure, critical and supercritical boilers; mountings, accessories, and fluidized bed combustion.
19	Fuel Handling and Combustion Systems – Coal handling, pulverizers, burners, draft systems, and ash handling.
20	Feed Water Treatment and Cooling Systems – Condensers, cooling towers, cooling ponds, and water treatment units.
21–22	Steam Turbine and Auxiliary Systems – Governing systems, reheating, feed heating, flange heating, gland sealing.
23	Operation, Maintenance and Efficiency of Steam Power Plant – Heat balance, performance calculations, site selection.
24	Diesel Power Plant – Layout and Components – Engine parts, operation principles, performance parameters.
25	Diesel Plant Systems – Fuel supply, lubrication, cooling, air intake, supercharging, and exhaust systems.
26	Performance and Heat Balance of Diesel Power Plant – Efficiency, operation control, site selection.
27	Comparative Study: Diesel vs. Steam Power Plant – Merits, demerits, and applications.
28–29	Gas Turbine Power Plant – Layout and Components – Open and closed cycles, cogeneration concepts.
30	Auxiliary Systems of Gas Turbine Power Plant – Fuel, control, lubrication, and maintenance.
31–32	Combined Cycle Power Plants – Gas-steam combined systems, advantages, and site selection criteria.
33–34	Nuclear Power Plant – Principles and Layout – Fission process, components, moderator, control rods, reactor cooling.

35	Nuclear Waste Management and Safety – Disposal methods, environmental issues, and site selection.
36–37	Hydro-Electric Power Plant – Principles and Classification – Site selection, hydrology, types of turbines, dam structures.
38	Operation and Maintenance of Hydro Plants – Run-off calculations, choice of units, interconnected systems.
39	Non-Conventional Power Plants and Electrical Systems – Solar, wind, geothermal, tidal; generators, transformers, cooling systems, instrumentation, and pollution due to power generation.

Text Books:

1. P.K. Nag, "Power Plant Engineering", Tata McGraw Hill.
2. F.T. Morse, "Power Plant Engineering", Affiliated East-West Press Pvt. Ltd, New Delhi/Chennai.

Reference Books:

1. El-Vakil, "Power Plant Technology", McGraw Hill.
2. R.Yadav , "Steam & Gas Turbines & Power Plant Engineering", Central Publishing House.

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	3	2	2	2	3	0	0	0	0	0	3
CO 2	3	3	1	3	1	0	0	0	0	0	3
CO 3	3	3	3	2	2	0	0	0	0	0	3
CO 4	3	2	1	2	2	0	0	0	0	0	0

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Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: Automobile Engineering **Credit: 3**

Subject Code: OEC-EE801B **Lecture Hours: 40**

Course Objective:

1. To understand basic of automobile engineering.
2. To get familiar with axels, steering systems, tyre & wheel assembly.
3. To understand suspension and brake system.
4. To understand vehicle performance and safety.
5. To understand automobile electrical system and latest advancement in vehicles

Course Outcome:

At the end of this course, students will demonstrate the ability to

CO1. Identify and description of different components and system of automobile
CO2. Explain working principle of various parts of automobile such as Axels, Wheels and Tyres, Steering systems
CO3. Explain working principle of various parts of automobile such as suspension and brake system.
CO4. Handle technical and management problems in automobile industry
CO5. Explain working principle of various of automobile electrical system.

Relevant Links:

Study Material **NPTEL Link** Coursera Link Linked In Learning

Detailed Syllabus:

Module number	Topic	Mapping with Industry and International Academia	Lecture Hours	Text Book	Mapped Chapter
1	Vehicle Structure and Engines-Types of Automobiles, Vehicle Construction – Chassis, Frame and Body ,Aerodynamics, Components of Engine – Their forms, Functions and Materials, Review of Cooling and Lubrication systems in Engine, Turbo Chargers, Engine Emission Control by 3–Way Catalytic Controller, Electronic Engine Management System.	**Cambridge open course: https://www-cvdc.eng.cam.ac.uk/**	**8**	1. Crolla, D. Automotive Engineering: Powertrain, Chassis System and Vehicle Body: Butterworth-Heinemann. 2.Heisler, H. Advanced vehicle technology: Butterworth-Heinemann. 3.Happian-Smith, J. An introduction to modern vehicle design: Butterworth-Heinemann.	**1,2**
2	Module 2: Engine Auxiliary Systems- Carburettor–working principle, Electronic fuel injection system – Mono-point and Multi - Point Injection Systems, Electrical systems – Battery generator –Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type)-Regulators-cut outs.	**Cambridge open course: https://www-cvdc.eng.cam.ac.uk/**	**10**	1. Crolla, D. Automotive Engineering: Powertrain, Chassis System and Vehicle Body: Butterworth-Heinemann. 2.Heisler, H. Advanced vehicle technology: Butterworth-Heinemann. 3.Happian-Smith, J. An introduction to modern vehicle design: Butterworth-Heinemann.	**3**

3	Module 3: Transmission Systems-Clutch – Types and Construction, Gear Boxes-Manual and Automatic, Simple Floor Mounted Shift Mechanism, Over Drives, Transfer Box Fluid flywheelTorque convertors, Propeller shaft – Slip Joint – Universal Joints, Differential and Rear Axle, Hotchkiss Drive and Torque Tube Drive.	**Cambridge open course: https://www-cvdc.eng.cam.ac.uk/**	**6**	1. Crolla, D. Automotive Engineering: Powertrain, Chassis System and Vehicle Body: Butterworth-Heinemann. 2.Heisler, H. Advanced vehicle technology: Butterworth-Heinemann.	**4**
4	Module 4: Steering, Brakes and Suspension- Wheels and Tires – Wheel Alignment Parameters , Steering Geometry and Types of steering gear box, Power Steering, Types of Front Axle – Suspension systems. Braking Systems – Types and Construction – Diagonal Braking System – Antilock Braking System.	**Cambridge open course: https://www-cvdc.eng.cam.ac.uk/**	**10**	1. Crolla, D. Automotive Engineering: Powertrain, Chassis System and Vehicle Body: Butterworth-Heinemann. 2.Heisler, H. Advanced vehicle technology: Butterworth-Heinemann. 3.Happian-Smith, J. An introduction to modern vehicle design: Butterworth-Heinemann.	5,6
5	Module 5: Alternative Energy Sources-Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles, Electric and Hybrid Vehicles, Fuel Cells.	**Cambridge open course: https://www-cvdc.eng.cam.ac.uk/**	**6**	1. Crolla, D. Automotive Engineering: Powertrain, Chassis System and Vehicle Body: Butterworth-Heinemann. 2.Heisler, H. Advanced vehicle technology: Butterworth-Heinemann.	6

Text Books:

1. Crolla, D. Automotive Engineering: Powertrain, Chassis System and Vehicle Body: Butterworth-Heinemann.
2. Heisler, H. Advanced vehicle technology: Butterworth-Heinemann.
3. Happian-Smith, J. An introduction to modern vehicle design: Butterworth-Heinemann.

Reference Books:

1. Newton, Steeds and Garet, Motor vehicles, Butterworth Publishers.
2. Crouse, W. H., & Anglin, D. L. Automotive Mechanics, Study Guide: McGraw-Hill.

Lesson Plan:

Working Day	Lesson Plan – Description
1	**Module 1:** Introduction to Automobiles – Classification, Vehicle Structure and Layouts
2	Chassis, Frame and Body Construction – Materials and Functions
3	Vehicle Aerodynamics – Drag, Lift, Downforce, Streamlining Techniques
4	Engine Components – Cylinder Block, Head, Piston, Crankshaft, Camshaft
5	Cooling System – Types, Components, Working and Comparison
6	Lubrication System – Wet & Dry Sump, Oil Grades, Filters
7	Turbocharging & Supercharging – Concepts, Types and Applications
8	Engine Emission Control – 3-Way Catalytic Converter and ECU Role
9	Electronic Engine Management Systems – Sensors, Actuators, Control Loops
10	**Module 1 Review & Tutorial Session (Numerical and Conceptual Problems)**
11	**Module 2:** Introduction to Engine Auxiliary Systems
12	Carburettor – Construction, Working Principle, Limitations
13	Electronic Fuel Injection (EFI) – Mono-point & Multi-point Systems
14	Battery Construction, Rating and Maintenance
15	Generator, Alternator and Starting Motor – Working and Drive Mechanisms
16	Ignition Systems – Battery, Magneto Coil and Electronic Types
17	Regulators and Cut-Outs – Function and Modern Electronic Control
18	**Module 2 Review & Class Test**
19	**Module 3:** Transmission Systems – Introduction and Need
20	Clutch – Types, Construction, and Working Principle
21	Gearbox – Types, Working of Manual Transmission

22	Automatic Transmission – Torque Converters, Fluid Flywheel
23	Overdrive and Transfer Box – Function and Mechanism
24	Propeller Shaft, Slip Joint, and Universal Joints
25	Differential and Rear Axle – Types, Construction, Working
26	Hotchkiss Drive and Torque Tube Drive
27	**Module 3 Tutorial / Practical Discussion**
28	**Module 4:** Steering System – Need, Geometry, and Types
29	Steering Gearbox Mechanisms and Power Steering Systems
30	Wheel and Tire Construction – Wheel Alignment Parameters
31	Front Axle Design and Suspension Systems – Leaf, Coil, Air Suspension
32	Braking Systems – Mechanical, Hydraulic, and Air Brakes
33	Diagonal and Dual-Circuit Braking Systems – Safety and Efficiency
34	Antilock Braking System (ABS) – Concept, Components, Operation
35	**Module 4 Review and Practical Case Study (ABS + Power Steering)**
36	**Module 5:** Introduction to Alternative Energy Sources
37	Natural Gas, LPG and Biodiesel Use in Automobiles
38	Hydrogen and Gasohol – Production, Storage, and Engine Modifications
39	Electric and Hybrid Vehicles – Architecture, Advantages, Limitations
40	Fuel Cells – Principle, Construction, Applications, and Course Summary

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

University of Engineering and Management
Institute of Engineering & Management, Salt Lake Campus
Institute of Engineering & Management, New Town Campus
University of Engineering & Management, Jaipur

Syllabus and Lesson Plan for B.Tech Admission Batch 2022

Subject Name: Sensors & Transducers **Credit: 3**

Subject Code: OECEE-801C **Lecture Hours: 40**

Course Objective:

1. **To provide a fundamental understanding of sensing principles** used for measuring physical, chemical, electrical, and biological quantities.
2. **To enable students to analyze, select, and compare different types of sensors and transducers** based on performance parameters such as sensitivity, accuracy, dynamic response, and environmental suitability.
3. **To develop the ability to design and integrate sensors with signal conditioning circuits**, data acquisition systems, and modern instrumentation interfaces.
4. **To prepare students to apply sensors and transducer technologies** in real-world applications including industrial automation, biomedical instrumentation, IoT systems, and environmental monitoring.

Course Outcome:

CO1: *Explain the operating principles, characteristics, and classification of various sensors and transducers used for measuring physical and electrical quantities.*

CO2: *Analyze and compare sensor performance parameters such as sensitivity, accuracy, resolution, dynamic response, and error sources.*

CO3: *Design appropriate signal-conditioning circuits and interfaces for sensor-based measurement systems.*

CO4: *Apply suitable sensors and transducers to solve real-world engineering problems in areas such as automation, IoT, biomedical systems, and industrial instrumentation.*

Relevant Links: NPTEL Link Coursera

Detailed Syllabus:

Module number	Topic	Mapping with Industry and International Academia	Lecture Hours	Text Book	Mapped Chapter
1	Mechanical & Electromechanical Sensors: Principle of sensing & transduction, classification; Potentiometric sensors (forms, materials, resolution, accuracy, sensitivity); Strain gauges (types, material, gauge factor, temperature effects, adhesives, rosettes); Inductive sensors (reluctance, mutual, transformer, magnetostrictive types); LVDT (construction, I/O curve); Proximity sensors.	*Relevant to*: Industrial automation, mechatronics, process instrumentation, automotive sensing systems; International alignment with courses from MIT, TU Delft, and Purdue on measurement systems & electromechanical sensing.	**12**	D.P. Patranabis – *Sensors & Transducers*	Ch. 1, 2, 3
2	Capacitive sensors (variable distance, area, dielectric constant, diaphragm type), microphone response; Piezoelectric sensors (piezoelectric effect, crystal model, natural/synthetic materials, ultrasonic sensors).	*Relevant to*: Semiconductor and MEMS-based sensing industries, consumer electronics, ultrasonic NDT; aligned with coursework from Georgia Tech & ETH Zurich.	**10**	D.P. Patranabis – *Sensors & Transducers*	Ch. 4,5

3	Thermal sensors: Expansion type, RTDs, thermistors, thermo-emf sensors (thermocouples), IC temperature sensors, PTAT sensors; Radiation sensors & pyroelectric sensors.	*Relevant to*: Thermal instrumentation, HVAC industry, semiconductor temperature sensing, biomedical devices; aligned with University of Michigan, Stanford sensing curriculum.	**10**	D.P. Patranabis – *Sensors & Transducers*	Ch. 6,7
4	Magnetic sensors (Villari, Wiedemann, Thomson, Hall effect sensors); Radiation/optical sensors (LDR, photodiodes, photovoltaic cells, photo-emissive sensors); Geiger counter, scintillation detector; Introduction to smart sensors.	*Relevant to*: Industrial robotics, power electronics, AIoT sensors, radiation detection industries; aligned with courses from UC Berkeley and KAIST.	**12**	D.P. Patranabis – *Sensors & Transducers*	Ch. 8,9,10

CO-PO mapping

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

Text Books:

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI

Reference Books:

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI
2. Instrument transducers, H.K.P. Neubert, Oxford University press.
3. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill