आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

Course Structure

&

Syllabus

Of

M.Tech
Electrical Engineering

[Applicable w.e.f. Academic Session - 2022-23]

[As per CBCS guidelines given by UGC]

SCHOOL OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD

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Moradabad.

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SCHOOL OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD.
www.iftmuniversity.ac.in

Study & Evaluation Scheme of
Master of Technology (M.Tech) Electrical Engineering

Programme:	***Master of Technology in Electrical Engineering***
Course Level:	***PG Degree***
Duration:	***02 Years (Four semesters) Full Time***
Medium of instruction:	***English***
Minimum Required Attendance:	***75%***
Maximum credits:	***58***

Programme Outcomes (POs):

Students completing this programme will be able to:

PO1: Acquire in-depth knowledge in the domain of power systems which have relevance to the global developmental needs.

PO2: Ability to critically analyze various power system components, models and their operation in order to fulfill the regional developmental needs.

PO3: Ability to apply fundamentals and concepts to analyze, formulate and solve complex problems of electrical power systems and its components for the fulfilment of regional developmental needs.

PO4: Apply advanced concepts of electrical power engineering to analyze, design and develop electrical components, apparatus and systems to put forward scientific findings at national and international levels.

PO5: Ability to use advanced techniques, skills and modern scientific and engineering tools for professional practice at global level.

PO6: Preparedness to lead a multidisciplinary scientific research team and communicate effectively at national and international levels.

PO7: Demonstrate and apply knowledge and understanding of engineering principles for project management in order to fulfill the local development needs.

PO8: To motivate exploring ideas and to encourage for independent, reflective and lifelong learning at local levels.

PO9: To understand the impact of engineering solutions in a global, economic, environmental and societal context.

Programme Specific Outcomes (PSOs):

The learning and abilities or skills that a student would have developed by the end of two-years.

PSO1: Understanding and Analyzing the real time problems and to develop solutions by Applying appropriate mathematical logic and algorithms.

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PSO2: Applying knowledge in various domains to identify research gaps and hence to provide solution to new ideas and innovations.

PSO3: Applying skills acquired for retrieving, analyzing and managing large data leading to effective decision making and application development using suitable engineering tools.

Choice Based Credit System (CBCS):

Choice based credit system (CBCS), provides a learning platform wherein the student or knowledge seeker has the flexibility to choose their course from a list of elective, core and soft skill courses. This is a student-centric approach to achieve his target number of credits as specified by the UGC and adopted by our University.

Groups of CBCS:

The following is the course module designed for the M.Tech program:

1. Engineering Core Courses (ECC)
2. Engineering departmental Elective (EDE)
3. Dissertation/Seminar (DS)

- **Engineering Core courses (ECC):**

  Engineering Core courses of M.Tech program will provide a holistic approach to master education, giving students an overview of the field, a basis to build and specialize upon. These core courses are the strong foundation to establish engineering knowledge and provide broad multi-disciplined knowledge can be studied further in depth during the elective phase.

  The core courses will provide more practical-based knowledge, case-based lessons and collaborative learning models. It will train the students to analyze, decide, and lead-rather than merely know-while creating a common student experience that can foster deep understanding, develop decision-making ability and contribute to the business and community at large.

  A wide range of core courses provides groundwork in the basic engineering disciplines: The integrated foundation is important for students because it will not only allow them to build upon existing skills, but they can also explore career options in a range of industries, and expand their understanding of various research fields.

- **Engineering Departmental Elective (EDE):**
  Engineering departmental Elective is an interdisciplinary additional subject that is compulsory in the first, second and third semester of a program. The score of Electives is counted in your overall aggregate marks under Choice Based Credit System (CBCS). Each Elective paper will be of 4 Credits and students will have the choice of taking electives. Each student has to take Electives from department other than the parent department. These courses are of 4 credits each.

- **Dissertation/Seminar(DS):**
  1. Dissertation with a department faculty.
  2. The students, who take up experiential dissertation in companies, where senior executives with a stake in teaching guide them, drive the learning. All students are encouraged to do some live project other than their regular classes.
  3.Industrial visit are essential to give students hand-on exposure and experience of how things and processes work in industries .Our institute organizes such visits to enhance students' exposure to practical learning and work out for are port of such a visit relating to their specific topic, course or even domain.

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M.Tech. Electrical Engineering: Two-Year (4-Semester) CBCS Programme			
Basic Structure: Distribution of Courses			
S.No.	**Type of Course**	**Credit**	**Total Credits**
1	**Engineering Core courses (ECC)**	09 Courses of 4 Credits each (Total Credit 9x4)	36
2	**Engineering Departmental Elective (EDE)**	02 Courses of 4 Credits each (Total Credit 2x4)	08
3	**Dissertation/Seminar(DS)**	02 Courses of 2 Credits each (Total Credit 2x2) 1 Course of 10 Credits (Total credit 1x10)	14
Total Credits			**58**

Evaluation of Performance

1. Programmes: Evaluation of performance of the students in a programme shall be a continuous process based on their performance in the class test, assignments and the end semester examinations.

Theory papers in semester system (Maximum Marks: 100)

The evaluation will be done through two class test and one end semester examination. This will be in addition to assignments, attendance, etc. Each class test will carry a weightage of 10 marks, and the end semester examination will carry a weightage of 70 marks. The remaining 10 marks will be awarded on the basis of attendance and performance in quizzes and assignments.

2. Dissertation, Seminar: Seminar, Dissertation, and other learning-oriented activities shall have associated maximum marks and credits, as stated in the syllabus.

3. Examination:

a. The minimum Grade required to pass in each Theory & Practical paper is 'GRADE D'.

b. A candidate, in order to pass, minimum CGPA of 4.50 is required in a particular academic year inclusive of both semesters of that academic.

c. There shall be no minimum Grade required to pass in General Proficiency (GP). However, Grade obtained in General Proficiency (GP) shall be included in SGPA.

d. For further information, examination ordinance of IFTM University can be followed.

	Evaluation Scheme		
	Internal	***External***	***Total***
Theory	***30***	***70***	***100***
Seminar	***100***	***--***	***100***
Pre-Dissertation	***50***	***50***	***100***
Dissertation	***250***	***250***	***500***

Unique practices adopted:

The method and practice of teaching, especially for teaching an academic subject or theoretical concept". In addition to conventional time-tested lecture method, the institute will emphasize on **experiential learning.**

Audio-Visual Based Learning:

It is clear that audio visual aids are important tools for teaching learning process. It helps the teacher to present the lesson effectively and students learn and retain the concepts better and for longer duration. Use of audio-visual aids improves student's critical and analytical thinking. It helps to remove abstract concepts through visual presentation. However, improper and unplanned use of these aids can have negative effect on the learning outcome. Therefore,

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teachers should be well trained through in-service training to maximize the benefits of using these aids. The curriculum should be designed such that there are options to activity-based learning through audio-visual aids. In addition, government should fund resources to purchase audio-visual aids in colleges

Field / Live Projects:
The objective of their training program is to enhance knowledge of the students on any one of the Trending technologies according to the industry standards without which the student degree is a mere degree. This is done by making students work on live projects which equip them with the required skill needed for the corporate world.

Personality Development Program (PDP):
It is conducted by professional trainers/experts from corporates as also by dedicated in-house faculty to actually bring a change in the traits of students in terms of values, behavior and personal growth. It enhances their body language, self-discipline, includes boosting one's confidence, improving language speaking abilities and widening one's scope of knowledge. Following PDP programs are undertaken in the Institute.

- **Aptitude:** Prepare students for placements by enhancing students' understanding in reasoning, numeric aptitudes, language proficiencies and general awareness.
- **Resume Writing:** Trains students about the current trend to present their Personal, Educational & Professional achievements and Strengths in an impressive manner. They learn how to write covering letter through which they can efficiently present their extra information. They also get an exposure to the Social Professional Sites like LinkedIn.
- **Group Discussion:** Help students to improve their ability to understand a topic/idea from different perspectives. They are able to realize its importance as a standard recruitment and selection tool. Students are trained to demonstrate their leadership, team work, oral and body language skills.
- **Personal Interview:** A platform to train students in improving their listening abilities and handling interviewer's questions and answer accordingly so that they are able to remove hesitation and anxiety during placement process.

Student Development Programs (SDP):
SDP has various modules dealing with professional development, Awareness and opinion building, communication and self-presentation etc. The purpose of these modules is to help students grow as individuals, develop the power of critical thinking and, at a material level, secure better placements

Special Guest Lectures (SGL):
Guest lectures are a highly useful medium to provide exceptional knowledge to students, it also adds an extra variety to the classroom routine and universities put a lot of emphasis on the importance of Guest lectures. The Guest lecturers are the "real-world" arriving in the classroom in order to make classes more interesting.

Industrial Visits:
Industrial visits are an integral part of Engineering and acknowledgment of technological up gradation. Industrial visit is considered as one of the tactical methods of teaching. The main reason behind this, it lets student to know things practically through interaction, working methods and employment practices. Moreover, it gives exposure from academic point of view. Main aim of industrial visit is to provide an exposure to students about practical working environment. They also provide students a good opportunity to gain full awareness about industrial practices. Through industrial visit students get awareness about new technologies. Technology development is a main factor, about which a students should have a good knowledge. Visiting different companies actually help students to build a good relationship with those companies.

Industry Focused programs:
Industry oriented education is an approach to learning from an industry perspective where core subjects are taught in the context of application of that knowledge to product design, development and operation. Establishing collaborations with various industry partners to deliver the programme on sharing basis. The specific courses/contents are to be delivered by industry experts to provide practice based insight to the students.

Mentoring scheme:
The new process has been established as Mentoring System". Each faculty will be the mentor of a group of 20 to 25 students. Every Student shall be provided with a faculty Mentor to help him /her in their personal & Academic Issues. The mentor maintains a register of all his/her mentees with complete personal & parents 'details. It is

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essential to have at least to meet once in a month. The mentor enters the discussions held, advice given and efforts & improvements made by the mentee.

Extracurricular Activities:

In IFTM University, various Co-Curricular and Extra-Curricular activities are regularly conducted along with regular Academic activities and students are continuously inspired and motivated to participate in these various activities to ensure the overall development of the students.

• **Cultural Activities:** The various activities undertaken are – Singing, Dancing, Playing Musical Instruments, Compering, Skit, Band, Stand-up Comedy, Poetry, Fashion Show etc. These activities help to develop self-confidence, cultural interest, creativity and sense of cooperation among students.

• **Games & Sports:** IFTM strongly believes that a healthy physique leads to a healthy mind. The Institute encourages sports culture and students also reciprocate by actively participating and distinguishing themselves at Sports Meets. IFTM possesses proper playgrounds and hard courts for outdoor sports. In Boys hostels students enjoy the facilities of Gym, badminton, and Table Tennis. The various sports activities undertaken are – cricket, football, basketball, volley ball, carom, chess, badminton, athletics etc. They increase self-esteem & mental alertness among students and promote team spirit. They also lead to balanced mental and physical growth of the students and teach them life skills like discipline, teamwork, leadership, patience, perseverance etc.

- **Induction program:** Every year induction program is organized for 1st year students to make them familiarize with the entire academic environment of university including Curriculum, Classrooms, Labs, Faculty/ Staff members, Academic calendar and various activities.

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SCHOOL OF ENGINEERING & TECHNOLGY
IFTM UNIVERSITY,MORADABAD

(Established under UPGovt.ActNo.24 of 2010 and approved under section 22 of UGC Act 1956)
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Telephone: 0591-2360817, 2360818 **Email:**admissions@iftmuniversity.ac.in
Website: www.iftmuniversity.ac.in

DEPARTMENT OF ELECTRICAL ENGINEERING

CBCS Programme

Effective from Session 2022-23

Course Code		CBCS BASKET	Credits			
Engineering Core Courses(ECC)			**L**	**T**	**P**	**C**
TMPS101		Wind and Solar Power Systems	3	1	0	4
TMPS102		Electrical Power Quality	3	1	0	4
TMPS103		Advanced Instrumentation	3	1	0	4
TMPS104		Neural Network, Fuzzy logic and Genetic Algorithms	3	1	0	4
TMPS201		Electrical Drives and Control	3	1	0	4
TMPS202		EHV AC & DC Transmission	3	1	0	4
TMPS203		Restructuring & Deregulation of power system	3	1	0	4
TMPS301		SCADA & Energy Management System	3	1	0	4
TMPS302		Power System Transients	3	1	0	4
Engineering Departmental Elective (EDE)			**L**	**T**	**P**	**C**
Elective - I	TMPS204(A)	Power System Dynamics and Control	3	1	0	4
	TMPS204(B)	Advanced Electromagnetic Theory	3	1	0	4
	TMPS204(C)	Digital Signal and image Processing	3	1	0	4
	TMPS204(D)	Computer Controlled Systems	3	1	0	4
	TMPS204(E)	Sustainable energy system	3	1	0	4
	TMPS204(F)	FACTS	3	1	0	4
	TMPS204 (G)	Industrial Automation and Control	3	1	0	4
	TMPS204(H)	Computer Controlled Systems	3	1	0	4
	TMPS204(I)	Smart Grid	3	1	0	4
	TMPS204(J)	Modeling & Simulation of power Electronic circuits	3	1	0	4
	TMPS204(K)	Power System Optimisation	3	1	0	4
	TMPS204(L)	Advanced Protecting Relaying	3	1	0	4
	TMPS204(M)	Smart Sensors & Instrumentation	3	1	0	4
Elective - II	TMPS303(A)	Transmission & Distribution Automation	3	1	0	4
	TMPS303(B)	Power System Reliability	3	1	0	4
	TMPS303(C)	Advanced Control System	3	1	0	4
	TMPS303(D)	Advanced Digital Communication	3	1	0	4
	TMPS303(E)	Power System Modeling	3	1	0	4
	TMPS303(F)	Control System design and estimation	3	1	0	4
	TMPS303(G)	Smart Grid Design and Analysis	3	1	0	4
	TMPS303(H)	Advanced Digital Communication	3	1	0	4
	TMPS303(I)	Optimization Techniques	3	1	0	4
	TMPS303(J)	Energy System Management	3	1	0	4
	TMPS303(K)	Non-Conventional Energy Sources & Energy Converters	3	1	0	4
	TMPS303(L)	Power System Planning	3	1	0	4
	TMPS303(M)	Electric and Hybrid Vehicles	3	1	0	4
Dissertation/Seminar (DS)			**L**	**T**	**P**	**C**
TMPS304		Seminar	0	0	4	2
TMPS351		Pre-Dissertation	0	0	4	2
TMPS451		Dissertation Work	0	0	20	10

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SCHOOL OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD

Master of Technology (M.Tech) Electrical Engineering

STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR I, SEMESTER- I

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	TMPS101	Wind and Solar Power Systems	3	1	0	20	10	30	70	100	4
2.	ECC	TMPS102	Electrical Power Quality	3	1	0	20	10	30	70	100	4
3.	ECC	TMPS103	Advanced Instrumentation	3	1	0	20	10	30	70	100	4
4.	ECC	TMPS104	Neural Network, Fuzzy logic and Genetic Algorithms	3	1	0	20	10	30	70	100	4
TOTAL				**12**	**04**	**00**	-	-	-	-	**400**	**16**

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DEPARTMENT OF ELECTRICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD

Master of Technology (M.Tech) Electrical Engineering

STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR II, SEMESTER-III

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	TMPS301	SCADA & Energy Management System	3	1	0	20	10	30	70	100	4
2.	ECC	TMPS302	Power System Transients	3	1	0	20	10	30	70	100	4
3.	EDE	TMPS303	Elective-II	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
4.	DS	TMPS304	Seminar	0	0	4	-	-	100	-	100	2
5.	DS	TMPS351	Pre-dissertation*	0	0	4	-	-	50	50	100	2
TOTAL				**09**	**03**	**08**	-	-	-	-	**500**	**16**

Elective – II (TMPS-303)

TMPS303(A)	Transmission & Distribution Automation
TMPS303(B)	Power System Reliability
TMPS303(C)	Advanced Control System
TMPS303(D)	Advanced Digital Communication
TMPS303(E)	Power System Modeling
TMPS303(F)	Control System design and estimation
TMPS303(G)	Smart Grid Design and Analysis
TMPS303(H)	Advanced Digital Communication
TMPS303(I)	Optimization Techniques
TMPS303(J)	Energy System Management
TMPS303(K)	Non Conventional Energy Sources & Energy Converters
TMPS303(L)	Power System Planning
TMPS303(M)	Electric and Hybrid Vehicles

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Note: The student has to select Elective in each semester.
Note: Dissertation to be started in III Semester and continued in IV Semester.

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DEPARTMENT OF ELECTRICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD

Master of Technology (M.Tech) Electrical Engineering

STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR II, SEMESTER-IV

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
PRACTICALS / PROJECT												
1.	DS	TMPS451	Dissertation Work	0	0	20	-	-	250	250	500	10
TOTAL				-	-	**20**	-	-	-	-	**500**	**10**

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DEPARTMENT OF ELECTRICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD

Master of Technology (M.Tech) Electrical Engineering

STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR I, SEMESTER- II

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	TMPS201	Electrical Drives and Control	3	1	0	20	10	30	70	100	4
2.	ECC	TMPS202	EHV AC & DC Transmission	3	1	0	20	10	30	70	100	4
3.	ECC	TMPS203	Restructuring & Deregulation of power system	3	1	0	20	10	30	70	100	4
4.	EDE	TMPS204	Elective-I	3	1	0	20	10	30	70	100	4
TOTAL				**12**	**04**	**00**	-	-	-	-	**400**	**16**

Elective – I (TMPS204)

TMPS204(A)	Power System Dynamics and Control
TMPS204(B)	Advanced Electromagnetic Theory
TMPS204(C)	Digital Signal and image Processing
TMPS204(D)	Computer Controlled Systems
TMPS204(E)	Sustainable energy system
TMPS204(F)	FACTS
TMPS204 (G)	Industrial Automation and Control
TMPS204(H)	Computer Controlled Systems
TMPS204(I)	Smart Grid
TMPS204(J)	Modeling & Simulation of power Electronic circuits
TMPS204(K)	Power System Optimisation
TMPS204(L)	Advanced Protecting Relaying
TMPS204(M)	Smart Sensors & Instrumentation

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Note: The student has to select Elective in each semester.

IFTM University, Moradabad
Department of Electrical Engineering

Master of Technology (M.Tech) Programme
(Effective from Session 2022-23)

TMPS101: WIND AND SOLAR POWER SYSTEMS

Objective: To provide comprehension idea about wind and solar power generation & to learn about the different electrical machines knowledge for better employability in industry.

UNIT-I **(08 Sessions)**

Wind Speed and Energy Distributions: Speed and Power Relations, Power Extracted from the Wind, Rotor Swept Area, Air Density, Global Wind Patterns, Wind Speed Distribution-Weibull Probability distribution, Mean and Mode speeds, Root Mean Cube Speeds, Energy Distributions, Digital Data Loggers, Effect of Height, Wind Speed Prediction knowledge for better employability in industry. **Wind Power System:** System Components, Turbine Rating, Variable-Speed Operation, System Design Features, Maximum Power Operation, System Control Requirements, Environmental Aspects for skill development.

UNIT-II **(08 Sessions)**

Electrical Generator: Electromechanical Energy Conversion, DC Machine, Synchronous Machine, Induction Machine, Induction Generator, Self-Excitation Capacitance, Torque-Speed Characteristic, Transients, **Generator Drives:** Speed Control Regions, Generator Drives, One Fixed-Speed Drive, Variable-Speed Using Gear Drive, Variable-Speed Using Power Electronics, Variable-Speed Drive, Drive Selection, Cut-Out Speed Selection knowledge for better employability in industry.

UNIT-III **(09 Sessions)**

Photovoltaic Power: Present Status, Building Integrated P-V Systems, P-V Cell Technologies **Solar Photovoltaic Power System:** The P-V Cell, Module and Array, Equivalent Electrical Circuit, Open Circuit Voltage and Short Circuit Current, i-v and p-v Curves, Array Design, Electrical Load Matching, Sun Tracking, Peak Power Point Operation, P-V System Components, **Solar Thermal System:** Energy Collection, Solar II Power Plant, Synchronous Generator, Commercial Power Plants Understanding for entrepreneurial skill.

UNIT-IV **(07 Sessions)**

Energy Storage: Battery, Types of Batteries, Equivalent Electrical Circuit, Performance Characteristics, Charge Regulators, , Superconducting Coil **Power Electronics Converters:** Basic Switching Devices, AC to DC Rectifier, DC to AC Inverter, Grid Interface Controls, Battery Charge/Discharge Converters, Power Shunts knowledge for better employability in industry.

UNIT-V **(08 Sessions)**

Stand-Alone System: P-V Stand-Alone, Wind Stand-Alone, Hybrid System, Mode Controller, Load Sharing, **Grid-Connected System:** Interface Requirements, Synchronizing with Grid, Operating Limit, Energy Storage and Load Scheduling **Electrical Performance:** Voltage Current and Power Relations, Quality of Power, Renewable Capacity Limit Understanding for entrepreneurial skill.

Course Outcomes:

CO1: Understand the concept and operation of wind power system and the control techniques used for this at local level for skill development.

CO2: Know about basic machines used as generator and type of generator drives for skill development, employability and entrepreneurship development.

CO3: Describes the photovoltaic cell and the various components used in the solar photovoltaic power system and how solar system can be used for energy collection globally for skill development, employability and entrepreneurship development.

CO4: Understand about the basic of energy storage and different type of power electronic converters used in power plants for skill development and employability.

CO5: Explain about the stand alone, grid connected system, smart grid technology and the power quality issues for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	2	2	2	3	3	3
CO2	3	3	3	2	2	2	3	3	3
CO3	3	3	3	2	2	2	3	3	3
CO4	3	3	3	2	2	2	3	3	3
CO5	3	3	3	2	2	2	3	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	1
CO5	2	3	1

Suggested Readings:

1. Mukund R. Patel "Wind and Solar Power Systems", CRC Press, 1999.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
5. B.H. Khan "Non-conventional Energy sources" Tata McGraw-Hill Publishing Company, New Delhi

Website Sources:

- http://www.awea.org/Resources/Content.aspx?ItemNumber=900
- http://www.windpowerwiki.dk/
- http://www.renewables-made-in-germany.com/en/renewables-made-ingermany-start/solar-energy/solar-thermal-energy/overview.html

Note: Latest editions of all the suggested readings must be used.

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IFTM University, Moradabad
Department of Electrical Engineering

Master of Technology (M.Tech) Programme
(Effective from Session 2022-23)

TMPS102: ELECTRICAL POWER QUALITY

Objective: To learn about the power quality monitoring concepts in power system & to understand the effect of harmonics, overvoltage and surges on power system for skill development and employability.

UNIT I **(08 Sessions)**

Introduction to Power Quality: Terms and definitions: Overloading, under voltage, sustained interruption; sags and swells; waveform distortion, Total Harmonic Distortion (THD), Computer Business Equipment Manufacturers Associations (CBEMA) curve for skill development and employability.

UNIT II **(08 Sessions)**

Voltage Sags and Interruptions: Sources of sags and interruptions, estimating voltage sag performance, motor starting sags, estimating the sag severity, mitigation of voltage sags, active series compensators, static transfer switches and fast transfer switches for skill development and employability.

UNIT III **(08 Sessions)**

Over voltages: Sources of over voltages: Capacitor switching, lightning, Ferro resonance; mitigation of voltage swells: Surge arresters, low pass filters, power conditioners – Lightning protection, shielding, line arresters, protection of transformers and cables, computer analysis tools for transients, PSCAD and EMTP for skill development and employability.

UNIT IV **(08 Sessions)**

Harmonics: Harmonic distortion: Voltage and current distortion, harmonic indices, harmonic sources from commercial and industrial loads, locating harmonic sources; power system response characteristics, resonance, harmonic distortion evaluation, devices for controlling harmonic distortion, passive filters, active filters, IEEE and IEC standards knowledge for better employability in industry.

UNIT V **(08 Sessions)**

Power Quality Monitoring: Monitoring considerations: Power line disturbance analyzer, per quality measurement equipment, harmonic / spectrum analyser; flicker meters, disturbance analyzer, applications of expert system for power quality monitoring for better employability and entrepreneurial skill.

Course Outcomes:

CO1: Study about power quality and the terms associated with this for skill development and employability.
CO2: Differentiate types of voltages sags and interruption in power system at international level for skill development.
CO3: Study the sources of overvoltage and protection against overvoltage and analyse the software tools like PSCAD and EMTP for skill development, employability and entrepreneurship development.
CO4: Study the effects of harmonics on various equipment's and understand the IEEE and IEC standards for skill development.
CO5: Understand power quality monitoring technique and their components nationally for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	2	2	3	3	2
CO2	3	3	3	2	2	2	3	3	2
CO3	3	3	3	3	3	2	3	3	2
CO4	3	3	3	3	3	2	3	3	2
CO5	3	3	3	2	2	2	3	3	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	3	2	1
CO3	2	3	2
CO4	3	2	1
CO5	2	3	2

Suggested Readings:

1. Heydt, G.T., „Electric Power Quality", Stars in a Circle Publications, Indiana, 2nd edition 1994.
2. Bollen, M.H.J "Understanding Power Quality Problems: Voltage sags and interruptions", IEEE Press. New York, 2000.
3. Arrillaga, J, Watson, N.R., Chen, S., „Power System Quality Assessment", Wiley, New York, 2000.
4. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, 'Electrical Power Systems Quality' McGraw Hill, 2003.
5. PSCAD User Manual.

Website Sources:

- www.academia.edu
- www.researchgate.net

Note: Latest editions of all the suggested readings must be used.

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TMPS103: ADVANCED INSTRUMENTATION

Objective: To learn about the working and applications of transducer & to be familiar with virtual instrumentation, recorders, industrial instruments and data acquisition system knowledge for better employability in industry.

UNIT I **(08 Sessions)**

Review of Analog transducers, Digital transducers-Digital encoders & their classifications, Resolution enhancement Coding limitations, Digital measurement of frequency & time. Digital phase meter, Digital capacitance meter Measurement of vibration-Necessity of vibration measurement, Analysis of vibration sensing devices, Measurement of shock, System characteristics for skill development.

UNIT II **(07 Sessions)**

Review of Signal Conditioning Signal processing, basic instrumentation amplifier-Linear gain control, Applications of Instrumentation amplifier - Transducer bridges, Isolation amplifiers, Filters, chopped and modulated d.c. amplifier, Modulators and Demodulators, Solid state modulator and Demodulator circuit for skill development.

UNIT III **(08 Sessions)**

Analog & Digital Data Acquisition System: Elements of digital data acquisition system. Magnetic tape recorders, F.M. recording, Digital recording methods – RZ & NRZ methods of recording, D/A & A/D converters. Simultaneous A/D converter, Counter type, Continuous type & Successive A/D converters. Sample & hold circuit. Multiplexing TDM &FDM methods, Spectral encoders to develop skill.

UNIT IV **(08 Sessions)**

Bio Medical Instrumentation: Sources of bio-electric potentials- Resting and action potentials, Propagation of action potentials, Transducers for biomedical applications, Bio-potential electrodes, Biochemical transducers.
Cardiovascular Measurements: The Heart and cardiovascular system, Electrocardiography, Measurement of blood pressure, Pacemakers- Pacemaker systems, Defibrillators understanding for entrepreneurial skill.

UNIT V **(08 Sessions)**

Industrial Instrumentation: Measurements of displacement, flow, moisture, liquid level & pressure/weight using digital transducers, **Methods of composition Analysis**: Spectroscopic methods, Absorption, Emission & Mass spectroscopy knowledge for better employability in industry.

Course Outcomes:

CO1: Study about analog and digital transducers and vibration sensing devices globally for skill development.
CO2: Review the concept of signal conditioning and instrumentation amplifier for skill development and employability.
CO3: Study about data acquisition system and their components in detail at international level for skill development, employability and entrepreneurship development.
CO4: Understand the biomedical instruments and how these instruments can be used in hospitals for skill development, employability and entrepreneurship development.
CO5: Study the industrial instruments and spectroscopy for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	3	3	3	3	3
CO2	3	2	2	3	3	3	3	3	3
CO3	3	2	2	3	3	3	3	3	3
CO4	3	2	2	3	3	3	3	3	3
CO5	3	2	2	3	3	3	3	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	2	3	2
CO4	2	3	2
CO5	2	3	1

Suggested Readings:

1. Instrumentation System & Devices – Rangan, Sarma & Mani
2. Electrical and Electronic Measurements – G.K.Banerjee
3. Industrial Instrumentation – Donald. P. Eckman.
4. Biomedical Instrumentation & Measurements – Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer

Website Sources:

- www.academia.edu
- www.researchgate.net
- https://ieeexplore.ieee.org
- www.nptel.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMPS104: NEURAL NETWORKS, FUZZY LOGIC AND GENETIC ALGORITHMS

Objective: To learn about the neural network and its applications & to learn about the fuzzy logic system and genetic theory understanding for entrepreneurial skill.

(09 Session)

UNIT-I
Neural Networks-1(Introduction & Architecture) : Introduction, Biological and Artificial Neuron Models. Nerve structure and synapse, Artificial Neuron and its model, Activation functions, Neural Network Architecture: Single layer and Multilayer Feed Forward networks, Recurrent networks, Various learning techniques, Perceptron Model and Perceptron Convergence theorem, Limitations and Applications of the Perceptron Model, Auto-associative and hetro associative memory understanding for entrepreneurial skill.

(09 Sessions)

UNIT-II
Neural Networks-II (Back Propagation Networks): Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient; back propagation algorithm, factors affecting back propagation training to develop skill, Applications of neural network in load flow study, load forecasting, detection of faults in distribution system and electric drives control knowledge for better employability in industry.

(08 Sessions)

UNIT-III
Fuzzy Logic-I (Introduction): Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory versus probability theory, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion for skill development.

(08 Sessions)

UNIT-IV
Fuzzy Logic –II (Fuzzy Membership, Rules): Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzifications, Fuzzy Controller, Industrial applications of fuzzy logic understanding for entrepreneurial skill.

(06 Sessions)

UNIT-V
Genetic Algorithm (GA): Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications understanding for entrepreneurial skill.

Course Outcomes:

CO1: Study about the basic idea of neural networks, its architecture and perception model with its applications for skill development and employability.
CO2: Understand the artificial neural network and back propagation method and its uses in detection of faults for skill development.
CO3: Understand basic concept of fuzzy logic, fuzzy set theory and its properties at local level for skill development.
CO4: Study about the fuzzy rules, algorithm and application of fuzzy logic in industry for skill development, employability and entrepreneurship development.
CO5: Understand the genetic algorithms and their applications at international level for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	3	3	3	3	3
CO2	3	2	2	3	3	3	3	3	3
CO3	3	2	2	3	3	3	3	3	3
CO4	3	2	2	3	3	3	3	3	3
CO5	3	2	2	3	3	3	3	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	3	2	1
CO3	3	2	1
CO4	2	3	1
CO5	2	3	1

Suggested Readings:

1. Yegnanarayana,B "Artificial Neural Networks," Prentice Hall of India.
2. Kumar Satish, "Neural Networks" Tata Mc Graw Hill
3. Siman Haykin,"Neural Networks", Prentice Hall of India

Website Sources:

- www.researchgate.net
- https://ieeexplore.ieee.org
- www.sciencedirect.com
- www.springer.com
- https://onlinelibrary.wiley.com

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TMPS201: ELECTRICAL DRIVES AND CONTROL

Objective: To learn about the power electronic devices and its applications & to learn about DC and AC drives and the voltage controllers understanding for better employability in industry.

UNIT I **(07 Sessions)**

Introduction, Power semiconductor devices- Thyristors- triggering methods, gate triggering, UJT triggering, PUT triggering, MoSFETs, TRIACS- Characteristics of TRIACs, Characteristics of GTOs, Characteristics of IGBTs, Characteristics of MCTCs. Converters-AC/AC converters, DC/DC converters, DC/AC converters. Dynamics of Electrical Drives, General configuration of a Motor Drive. Determination of Moment of Inertia, Numerical Examples understanding for better employability in industry.

UNIT II **(09 Sessions)**

D.C. Drives: Review of various types of d.c. motors and their characteristics, Ward Leonard method of speed control of a d.c. motor Controlled Rectifier Circuits- Chopper circuits, Single phase Dual converter drives, Electric braking. Electrical braking of rectifier controlled separately excited d.c. motor, Thyristor control of a d.c. series motor. Microprocessor based speed control of a separately excited d.c. motor, Chopper control of d.c. series motor, Multi quadrant Control of Chopper drives, Numerical Examples for skill development.

UNIT III **(07 Sessions)**

A.C Voltage controllers, A.C. Regulators- Half wave regulators, Delta connected regulators, Inverters- PWM Inverters, Variable Voltage Variable Frequency Control Method, Voltage source Inverter Drives, Current Source Inverter Drives, Cycloconverters, Rotor resistance control of SRIM, Numerical Examples for skill development.

UNIT IV **(09 Sessions)**

A.C. Motor Drives- Review of Induction Motor Drives, Modified Speed-Torque Characteristics Three phase Induction motor, Methods of speed control-Stator voltage control, Rotor voltage control, V/F control, Soft starting, Static Scheribius Control and Static Kramer control of Induction Motor Drives, Industrial Microprocessor based speed control of three phase Induction motors, Single phase Induction motor Drives, Industrial applications, Numerical Examples for skill development.

UNIT V **(08 Sessions)**

Synchronous Motor Drives- Steady state characteristics, Torque angle characteristics, Braking of Synchronous motors- Dynamics of braking. Types of Synchronous motors, VSI Drives, Load Commutated Inverter Drives (CSI Drives) Cycloconverter Drives, Stepping Motors-Variable Reluctance Stepping Motors and Drive circuits, Permanent magnet Stepping Motors, Hybrid Stepping Motors, Switched Reluctance Stepping Motors and Drive circuits, Brushless D.C. Motor Drives, Numerical Examples for skill development.

Course Outcomes:

CO1: Review about power semiconductor devices, different power electronic converters and motor drives at local level for skill development and employability.

CO2: Understand the operation of different types of DC drives for skill development and employability.

CO3: Understand the operation of AC voltage controllers, inverters and cyclo converters for skill development, employability and entrepreneurship development.

CO4: Understand the operation of AC Motor Drives and speed control methods and applications in industry for skill development, employability and entrepreneurship development.

CO5: Learn the operation of synchronous motor drives and stepper motors with examples nationally for skill development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	2	3	3	3	3
CO2	3	2	2	2	2	3	3	3	2
CO3	3	2	3	2	2	3	3	3	2
CO4	3	2	3	2	2	3	3	3	2
CO5	3	2	3	2	2	3	3	3	2

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	2
CO4	2	3	2
CO5	2	3	1

Suggested Readings:

1. Electric Drives- N.K.De and P.K. Sen, PHI Learning
2. Power Semiconductor Controlled Drives- GK Dubey, S.Chand & Co.
3. A First Course in Electric Drives- S.K.Pillai , New Age International Publications

Website Sources:

- www.lecturenotes.in
- www.studentsfocus.com
- www.electrical-engineering-portal.com
- www.nptel.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMPS202: EHV AC & HVDC TRANSMISSION

Objective: To learn about the need of AC high voltage system in transmission line & to learn about the HVDC transmission system and protection schemes for under-voltage and overvoltage surges knowledge for better employability in industry.

UNIT I **(05 Sessions)**

Introduction: Need of EHV AC Transmission, Comparison of EHV AC & HVDC Transmission, Mechanical Considerations of Transmission Line for skill development.

UNIT II **(10 Sessions)**

EHV AC Transmission: Parameters Of EHV Lines, Voltage Gradient In Bundle Conductors Lines, Conductor Sizing, Over-Voltages Due To Switching, Ferro-Resonance. Insulation Coordination Line Insulators and Clearances, Corona & Its Effects, Power Loss, Audible Noise and Radio-Interference, Long Distance Transmission With Series And Shunt Compensations, Principle Of Half Wave Transmission, Flexible Ac Transmission knowledge for better employability in industry.

UNIT III **(08 Sessions)**

HVDC TRANSMISSION: General Aspects Of D.C. Transmission & its comparison with A.C. Transmission, Different Types Of Power Rectifiers & High Voltage Rectifiers (Converter Circuits), Analysis Of Bridge Converter, Converter Control & Operation, Inversion, Harmonics & Filters, Converter Fault & Protection understanding for entrepreneurial skill.

UNIT IV **(10 Sessions)**

Protection of High Voltage D.C. Systems, D.C. Circuit Breakers, Cable Lines and Overhead Lines for D.C. Transmission, Steady State & Transient State Characteristics of D.C. Power Transmission Systems. Influence of A D.C. Transmission System on the Steady State Stability & Transient Stability of an Associated A.C. Power System understanding for entrepreneurial skill.

UNIT V **(07 Sessions)**

Extra H.V.D.C. Transmission, H.V.D.C. Thyristors, Their Constructional Details & Operating Principles, Analysis of Converter & Inverter Operation: Control of H.V.D.C. Link understanding for entrepreneurial skill.

Course Outcomes:

CO1: Qualitative comparison of AC and DC transmission system with all aspects at international level for skill development.

CO2: Understand the terms associated with EHV AC transmission and FACTS for skill development, employability and entrepreneurship development.

CO3: Study the comparison of AC and DC transmission and components of HVDC transmission globally for skill development, employability and entrepreneurship development.

CO4: Understand the stability analysis and protection of HVDC system for skill development and employability.

CO5: Understand the HVDC transmission for high voltages and their constructional and operational details for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	3	3	2	2
CO2	3	2	3	2	2	3	3	2	2
CO3	3	3	3	2	2	3	3	2	2
CO4	3	3	3	3	3	3	3	2	2
CO5	3	3	3	2	2	3	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	2
CO5	2	3	1

Suggested Readings:

1. EHV-AC and HV DC Transmission Engineering Practice". S. Rao"
2. H.V.D.C Power Transmission System" - K.R. Padiyar
3. "Extra High Voltage AC Transmission Engineering" Rakosh Das Begamudre

Website Sources:

- www.lecturenotes.in
- www.scribd.com
- www.researchgate.net
- https://ieeexplore.ieee.org
- www.sciencedirect.com

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TMPS203: RESTRUCTURING AND DEREGULATION OF POWER SYSTEM

Objective: To learn about power scheduling in electrical systems & to learn about the electricity market characteristics and the role of different parameters which affect its cost of distribution knowledge for better employability in industry.

UNIT-I **(07 Sessions)**
Open access in electricity sector, types of open access- medium term. Competitive Electricity Market and Balancing Mechanism, Scheduling knowledge for better employability in industry.

UNIT-II **(09 Sessions)**
Traditional Central Utility Model, Reform Motivations, Separation of Ownership and Operation, Central Dispatch versus Market Solution, Independent System Operator (ISO)for skill development, Components of Restructured Systems: Gencos, Discos and Retailers.

UNIT-III **(08 Sessions)**
Wholesale Electricity Market Characteristics: Central Auction, Bidding, Market Clearing and Pricing, Bilateral Trading, Scheduling, Gaming, Ancillary, Maximalist ISO, Minimalist ISO Model. Deregulation in Distribution for better employability in industry.

UNIT-IV **(08 Sessions)**
Role of TP: Vertically Integrated Utility, Three Models of the Electricity Market, For-profit TP. Incentive Rate Design, Priority Insurance Scheme, Transmission Expansion in deregulated Environment, Transmission Owners understanding for entrepreneurial skill.

UNIT-V **(08 Sessions)**
ISOs, Power Exchange (PX), Scheduling Coordinators. PX and ISO: Functions and Responsibilities, Trading Arrangements: The Pool, Pool and Bilateral Trades, Multilateral Trades, Congestion Management in Open-access Transmission Systems, Open-access Coordination Strategies understanding for entrepreneurial skill.

Course Outcomes:

CO1: Analyse the electricity market and the different terms used with it for skill development and employability.
CO2: Understand the basic functioning and planning activities of ISO globally for skill development, employability and entrepreneurship development.
CO3: Understand wholesale electricity market characteristics and concepts for skill development, employability and entrepreneurship development.
CO4: Study about models of electricity market, insurance scheme and transmission at international level for skill development and employability.
CO5: Understand the scheduling coordinators, power exchange and type of trade in electricity for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	3	3	2	2
CO2	3	2	3	2	2	3	3	3	3
CO3	3	2	3	2	2	3	3	3	3
CO4	3	2	3	2	2	3	3	3	3
CO5	3	2	3	2	2	3	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	2
CO3	2	3	2
CO4	2	3	1
CO5	2	3	2

Suggested Readings:

1. Loi Lei Lai, "Power System Restructuring and Deregulation: Trading Performance and Information Technology", John Wiley & Sons Ltd.
2. CERC Regulations on Grand og Connectivity, Medium term Open Access and Long Term Open Access; Regulations.
3. CERC Regulation on Open Access-2008 [CERC Compendium].
4. POSOCO Manual on Electricity Market.

Website Sources:

- www.researchgate.net
- https://onlinelibrary.wiley.com
- https://ieeexplore.ieee.org
- www.nptel.ac.in
- www.academia.edu
- https://link.springer.com

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TMPS204(A): POWER SYSTEM DYNAMICS AND CONTROL

Objective: To learn about the modelling of synchronous machine and park transformation & to learn about the different types of excitation system and their applications understanding for entrepreneurial skill.

UNIT-I **(10 Sessions)**

Synchronous Machine Modelling: Schematic Diagram , Physical Description: armature and field structure, machines with multiple pole pairs, mmf waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 trans formation understanding for entrepreneurial skill.

UNIT-II **(06 Sessions)**

Excitation Systems: Excitation System - Requirements, Elements of Excitation System, types of Excitation System: Rotating Rectifier and Potential-source controlled-rectifier systems: hardware block diagram and IEEE (1992) Type ST1A block diagram knowledge for better employability in industry.

UNIT-III **(08 Sessions)**

Automatic Generation Control: Fundamentals of speed governing - control of generating unit Power output– composite regulating characteristic of Power Systems – Response rates of turbine – governing systems– fundamentals of automatic generation control –Implementation of AGC knowledge for better employability in industry.

UNIT-IV **(10 Sessions)**

Reactive Power And Voltage Control: Modelling of AVR loops : Components – stability compensation - Production and absorption of reactive Power – methods of voltage control - shunt reactors – shunt capacitors – series capacitors – synchronous condensers – static var systems-Principle of transmission system compensation – modeling of reactive compensating devices – Application of tap changing transformers to transmission systems- distribution system voltage regulation – modeling of transformer ULTC control systems for skill development.

UNIT-V **(06 Sessions)**

Voltage stability: - Basic concept, transmission system characteristics, generator characteristics, load characteristics, PV curve, QV curve and PQ curve, characteristics of reactive power compensating devices. Voltage collapse and prevention of voltage collapse for skill development.

Course Outcomes:

CO1: Understand the synchronous machine modelling methods and mathematical descriptions for skill development.
CO2: Study the elements and types of excitation systems for skill development and employability.
CO3: Understand the fundamentals of speed governing system and automatic generation control at local level for skill development and employability.
CO4: Study the reactive power and voltage control methods and principle of transmission system compensation for skill development, employability and entrepreneurship development.
CO5: Understand the basic concept of voltage stability and different stability curves at international level for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	3	3	2	2
CO2	3	2	3	2	2	3	3	2	2
CO3	3	3	3	2	2	3	3	2	2
CO4	3	2	3	3	3	3	3	2	2
CO5	3	2	3	3	3	3	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	2
CO5	2	3	2

Suggested Readings:

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. P.M Anderson and A.A Fouad, "Power System Control and Stability", Iowa State University Press, Ames, Iowa, 1978
3. Elgerd O.I, "Electric Energy System Theory: an Introduction" - Tata McGraw Hill, New Delhi – 2002Mahalanabis A.K., Kothari. D.P. and Ahson.S.I., "Computer Aided Power System Analysis and Control", TMH,1984.

Website Sources:

- www.springer.com
- www.nptel.ac.in
- www.onlinelibrary.wiley.com

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TMPS204(B): ADVANCED ELECTROMAGNETIC THEORY

Objective: To learn about the behaviour of EM-wave in electrostatic and magnetic field & to analyze the behaviour of EM- wave in different media and also obtain their characteristic understanding for entrepreneurial skill.

UNIT I **(06 Sessions)**
Maxwell equations for varying fields, Retarded potentials, Electromagnetic waves, Fields in anisotropic media to develop skill.

UNIT II **(09 Sessions)**
Review of electrostatic & steady magnetic fields, Inconsistency of Ampere's law. Maxwell's equations, Conditions at a boundary surface, Electromagnetic plane wave. Interaction of electron beams &e.m. fields knowledge for better employability in industry.

UNIT III **(09 Sessions)**
Wave Equations, General solution of a wave Equations, Polarization, Reflection by a perfect conductor – Normal Incidence, Reflection by a perfect dielectric- normal Incidence. Reflection at the surface of a conductive medium, Poynting Vector and Power flow knowledge for better employability in industry

UNIT IV **(08 Sessions)**
Wave propagation in gyro tropic media, Magnetic properties of ferrites, Tensor permeability, Faraday rotation, Ferrite Junction circulator, Symmetrical circulator, scattering matrix theory for skill development.

UNIT V **(08 Sessions)**
Numerical Electromagnetism, The Finite Difference method, The Moment method, The Finite element method Scattering & Diffraction of E.M. waves understanding for entrepreneurial skill.

Course Outcomes:

CO1: Study about maxwell equations and electromagnetic waves at international level for skill development.
CO2: Review electrostatic and magnetic fields, maxwell equations, boundary conditions and plane waves for skill development and employability.
CO3: Study the overall concept of wave equations for skill development.
CO4: Study about wave propagation and scattering matrix theory nationally for skill development.
CO5: Understand the diffraction of electromagnetic waves and numerical electromagnetism for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	3	3	2	2
CO2	3	2	3	3	3	3	3	2	2
CO3	3	2	3	2	2	3	3	2	2
CO4	3	2	3	2	2	3	3	2	2
CO5	3	2	3	2	2	3	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	3	2	1
CO4	2	3	1
CO5	2	3	1

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Suggested Readings:

1. E.M. Field theory, Antenna & Wave Propagation – P.C. Dhar.
2. E.M. Waves & Radiating Systems – Jordan & Balman.
3. Electromagnetic Fields and Applications - Babu. R. Vishwakarma

Website Sources:

- www.ocw.mit.edu
- www.springer.com
- www.britannica.com
- www.electrical-engineering-portal.com
- www.nptel.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(C): DIGITAL SIGNAL AND IMAGE PROCESSING

Objective: To study about the different kinds of signals (analog, digital, continues and discrete) & to study about the convolution technique and fourier analysis for discrete systems knowledge for better employability in industry.

UNIT-I **(09 Sessions)**

Introduction to Discrete Time Signals & System: Discrete–Time Signals representation and Manipulation, Discrete–Time Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) Systems, Impulse Response, Transfer Function, Difference Equation, Frequency Domain and Time Domain Analysis of Infinite Impulse Response (IIR) filter and Finite Impulse Response (FIR) filter, Correlation, Linear and Circular and Convolution Algorithm understanding for entrepreneurial skill.

UNIT-II **(08 Sessions)**

Discrete Fourier Transform: Discrete Time Fourier Transform (DTFT), Frequency Domain Sampling, Properties of Discrete Fourier Transform(DFT), Decimation In Time Fast Fourier Transform (DIT-FFT) algorithm, Spectral Analysis using Fast Fourier Transform (FFT), Linear Finite Impulse Response(FIR) filtering using Fast Fourier Transform (FFT) based Overlap Save And Overlap Add Method understanding for entrepreneurial skill.

UNIT-III **(09 Sessions)**

Image Transforms: Introduction to Unitary Transform, Discrete Fourier Transform (DFT), Properties of 2-D Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Inverse Fast Fourier Transform (IFFT), Walsh transform, Hadamard Transform, Discrete Cosine Transform, Discrete Wavelet Transform understanding for entrepreneurial skill.

UNIT-IV **(07 Sessions)**

Image Enhancement: Gray Level Transformations, Histogram Processing

Spatial Filtering: Introduction, Smoothing and Sharpening Filters, Color Image Enhancement knowledge for better employability in industry.

UNIT-V **(08 Sessions)**

Image Segmentation and Representation: Detection of Discontinuities, Appalachian of Gaussian, Derivative of Gaussian, Canny Edge Detection, Threshold in Hierarchical Data Structures, Border Tracing, Edge linking and Boundary Detection, Threshold, Region Based Segmentation. Representation Schemes understanding for entrepreneurial skill.

Course Outcomes:

CO1: Use concepts of trigonometry, complex algebra, Fourier transform, z-transform to analyze the operations on signals and acquire knowledge about Systems at international level for skill development.

CO2: Select proper tools for analog-to-digital and digital-to-analog conversion. Also select proper tools for time domain and frequency domain implementation for skill development, employability and entrepreneurship development.

CO3: Design, implementation, analysis and comparison of digital filters for processing of discrete time signals for skill development, employability and entrepreneurship development.

CO4: Integrate computer-based tools for engineering applications nationally for skill development and employability.

CO5: Employ signal processing strategies at multidisciplinary team activities for skill development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	3	3	2	2	2	2
CO2	3	2	3	3	3	2	2	2	2
CO3	3	2	3	3	3	2	2	2	2
CO4	3	2	3	3	3	3	3	3	2
CO5	3	2	3	2	2	3	3	3	2

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	2
CO5	3	2	2

Suggested Readings:

6. Sanjay Sharma,"Digital Signal Processing", S.K.Kataria & Sons.
7. Salivahnan, "Digital Signal Processing", Tata Mcgraw-Hill.
8. Johnny R. Johnson, "Digital Signal Processing", PHI Learning Pvt Ltd., 2009
9. John G Prokias, Dimitris G Manolakis, "Digital Signal Processing", Pearson Education.
10. Oppenheim & Schafer, "Digital Signal Processing" PHI Learning

Website Sources:

- https://ocw.mit.edu
- www.lecturenotes.in
- www.examupdates.in
- www.nptel.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(D): ADVANCED TOPICS IN POWER SYSTEM

Objective: To understand how to analyze the stability of a power system, how to improve the stability and finally how to prevent system becoming unstable for skill development and employability.

UNIT-I: **(07 Sessions)**

Generation Control Loops, AVR Loop, Performance and Response, Automatic Generation Control of Single Area and Multi Area Systems, Static and Dynamic Response of AGC Loops for skill development and employability, Economic Dispatch and AGC..

UNIT-II: **(07 Sessions)**

Transient Stability Problem, Modeling Of Synchronous Machine, Loads, Network, Excitation and Systems, Turbine And Governing Systems, Trapezoidal Rule Of Numerical Integration Technique For Transient Stability Analysis, Data For Transient Stability Studies, Transient Stability Enhancement Methods for skill development and employability.

UNIT-III: **(07 Sessions)**

Low Frequency Oscillations, Power System Model For Low Frequency Oscillation Studies, Improvement Of System Damping With Supplementary Excitation Control, Introduction To Sub Synchronous Resonance and Countermeasures for employability.

UNIT-IV: **(07 Sessions)**

Voltage Stability Problem, Real And Reactive Power Flow In Long Transmission Lines, Effect Of ULTC And Load Characteristics On Voltage Stability, Voltage Stability Limit, Voltage Stability Assessment Using PV Curves, Voltage Collapse Proximity Indices, Voltage Stability Improvement Methods for employability.

Unit-V: **(07 Sessions)**

Contingency analysis ZBUS Method in Contingency Analysis, Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single Contingencies, Analysis of Multiple Contingencies, Contingency Analysis of DC Model, System Reduction for Contingency and Fault Studies for employability and entrepreneurship development.

Course Outcomes:

On completion of the course students will be able to

CO1: Understand facts, concepts and classification of stability on the basis of perturbation and economical aspect of energy exchange at local level for skill development and employability.

CO2: Analyze the characteristics of synchronous alternator under small and large disturbances foremployability.

CO3: Apply knowledge of electrical subjects for solving stability problem and use method for enhancing stability for employability.

CO4: Understand and analyze the voltage stability problems and methods of improving voltage stability for employability and entrepreneurship development.

CO5: Understand and analyze the contingency issues in lines and apply the different techniques to improve it globally for employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	1	3	2
CO5	1	3	2

Suggested Readings:

1. Electric Energy System Theory: An Introduction. O.I. Elgard, .II Edition, McGraw Hill, New York, 1982.
2. Power Generation, Operation And Control., A.J. Wood, B.F. Wollenberg, .John Wiley And Sons, New York, 1984, 2nd Edition: 1996.
3. Computer Modeling Of Electrical Power Systems., J. Arrilaga, C.P. Arnold, B.J. Harker, Wiley, New York, 1983.
4. Power System Engineering, I.J. Nagrath, O.P. Kothari, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
5. Electric Power System Dynamics, Yao-Nan-Yu, 6. Power System Stability and Control. P. Kundur McGraw Hill, New York, 1994.

Website Sources:

1. www.easyengineering.net
2. www.electrical-engineering.net
3. www.lecturenotes.in
4. www.academia.edu
5. www.nptel.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(E): SUSTAINABLE ENERGY SYSTEMS

Objective: This course examines the production and consumption of energy from a systems perspective. Sustainability is examined by studying global and regional environmental impacts, economics, energy efficiency, consumption patterns and energy policy to provide skill development, employability and entrepreneurship development.

Unit I **(08 Sessions)**

INTRODUCTION AND ENERGY FUNDAMENTALS

Sustainable Energy Systems: Issues for the 21st century, Physics of Energy: Laws of Thermodynamics, Energy Accounting I: EIA Conventions, Energy Accounting II: LCA Conventions for skill development and entrepreneurship development.

Unit II **(08 Sessions)**

ENERGY PRODUCTION AND CONSUMPTION (SUPPLY AND DEMAND)

Overview of Energy Production and Consumption, Fossil Energy Resources, Electricity From Fossil Sources, Electricity from Nuclear Fuels and Other Generating Systems, Electricity: Power Plant Economics and Regulation, Industrial Sector, Commercial and Residential Sectors, Transportation Sector for skill development and employability.

Unit III **(08 Sessions)**

STRATEGY – TRANSITION TO RENEWABLE TECHNOLOGIES

Introduction to Renewable Energy, Wind Energy, Hydropower and Other Renewable Electricity Sources, Photovoltaics, Biomass: Electricity for skill development and employability.

Unit IV **(08 Sessions)**

STRATEGY – ALTERNATIVE FUELS AND VEHICLE TECHNOLOGY?

Biomass: Transport Fuels, Which Option? Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Plug in Hybrid Electric Vehicles (PHEV) or Fuel Cell Vehicles (FCV) for skill development, employability and entrepreneurship development.

Unit V **(08 Sessions)**

STRATEGY – STORAGE TOPICS

Electricity Storage Technologies, Carbon Sequestration, Climate Change I: Climate Change Science, Climate Change II: Climate Change Mitigation and Policy for skill development, employability and entrepreneurship development.

Course Outcomes:

On completion of the course students will be able to

CO1: Introduction and Energy Fundamentals for skill development and entrepreneurshipdevelopment.
CO2: Energy Production and Consumption at local level for skill development and employability.
CO3: Renewable Energy Technologies for skill development and employability.
CO4: Alternative Fuels and Vehicle Technology for skill development, employability and entrepreneurship development.
CO5: Storage Topics at international level for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	2	2	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	3
CO2	2	3	1
CO3	2	3	1
CO4	2	3	3
CO5	2	3	3

Suggested Readings:

1. Energy for sustainability: technology, planning and policy Island Press 2008.
2. Sustainable energy: choosing among options MIT Press 2005
3. World energy assessment: energy and the challenge of sustainability / New York, NY: United Nations Development Programme, c2000.
4. Energy systems and sustainability / Oxford: Oxford University Press in association with the Open University, 2003.
5. Renewable energy: power for a sustainable future / Oxford: Oxford University Press in association with the Open University, 1996.

Website Sources:

- www.lecturenotes.in
- www.examupdates.in
- www.iare.ac.in
- www.notes.specworld.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(F): FACTS

Objective: FACTS stands for Flexible Alternating Current Transmission System or simply Flexible AC Transmission System. It is a power electronic based system where static devices are used to enhance and increase the the power transfer capability and controllability to provide skill development, employability and entrepreneurship development.

Unit I **(08 Sessions)**

Facts concepts:

Reactive power control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers for skill development.

Unit II **(08 Sessions)**

Static shunt and series compensators:

Shunt compensation – objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators–

SVC, STATCOM, SVC and STATCOM comparison. Series compensation– objectives of series compensation, thyristor switched series capacitors(TCSC), static series synchronous compensator(SSSC), power angle characteristics, and basic operating control schemes for skill development and employability.

Unit III **(08 Sessions)**

Combined compensators:

Unified power flow controller (UPFC) – Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters for skill development and employability.

Unit IV **(08 Sessions)**

HVDC transmission:

HVDC Transmission system: Introduction, comparison of AC and DC systems, applications of DC transmission, types of DC links, Layout of HVDC Converter station and various equipment's. HVDC Converters, analysis of bridge converters with and without overlap, inverter operation, equivalent circuit representation of rectifier and inverter configurations for employability and entrepreneurship development.

Unit V **(08 Sessions)**

Control of HVDCsystem:

Principles of control, desired features of control, converter control characteristics, power reversal, Ignition angle control, current and extinction angle control. Harmonics introduction, generation, ac filter sand dc filters. Introduction to multi terminal DC systems and applications, comparison of series and parallel MTDC systems, Voltage Source Converter based HVDC systems for skill development and employability.

Course Outcomes:

On completion of the course students will be able to

CO1: Understand the operations of different FACTS devices at international level for skill development.
CO2: Describe the principle of operation and configuration of Static Shunt and Series Compensators for skill development and employability.
CO3: Describe the basics of Unified & Interline power flow controller for skill development and employability.
CO4: Learn various power quality issues of power lines globally for employability and entrepreneurship development.
CO5: Identify the controllers for different Contingencies for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	2	2	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2

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CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	2
CO2	3	3	1
CO3	3	3	1
CO4	1	3	3
CO5	3	3	1

Suggested Readings:

1. Hingorani ,L.Gyugyi, _Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000 ISBN –078033 4588.
2. Padiyar, K.R., _HVDC transmission systems', Wiley Eastern Ltd., 2010.
3. Mohan Mathur R. and Rajiv K.Verma , _Thyristor – based FACTS controllers for Electrical Transmission systems', IEEE press, Wiley Inter science , 2002
4. Padiyar K.R., _FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007.

Website Sources:

- www.lecturenotes.in
- www.examupdates.in
- www.iare.ac.in
- www.notes.specworld.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(G): Industrial Automation & Control

Objective: To make the aspiring engineers acquainted with the conceptual as well as practical knowledge of the PLC programming& latest technologies being used to achieve PLC Industrial Automation to provide skill development, employability and entrepreneurship development.

Unit I: **(07 Sessions)**

Introduction of Automation system

Introduction to Industrial Automation, Requirement of automation systems, Application areas, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA) to provide skill development and employability, Industrial communication protocols: modbus & profibus

Unit II: **(07 Sessions)**

Automation using relay logic Relay Circuits

Construction & Principle of Operation, Types of Relays, Relay as a memory element, Contactor Circuits, Advantages of Contactors over Relay, DOL circuit implementation using contactor, Automation problems based on relays for skill development, employability and entrepreneurship development, PLC Introduction: History & Current Trends, Basic Block Diagram of PLC, Classification of PLCs

Unit III: **(07 Sessions)**

Automation using PLC

Types of PLC I/O: Analog and Digital, Sink and Source concept, PLC programming: Ladder diagram, Sequential flow chart, ladder programming, Timer instructions – On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, math instructions to provide skill development and employability .

Unit IV: **(07 Sessions)**

Industrial sensors and its application

Introduction to Industrial sensors: optical, inductive, capacitive Sensors, PNP and NPN senor concept, interfacing of sensors with PLC, 4-20 ma current loops, HART protocol, modes of HART protocol to provide employability and entrepreneurship development.

Unit V: **(07 Sessions)**

Basics of Pneumatics and its use in automation

Introduction to Pneumatics, Role in industries, Laws : Boyel's law, Charle's Law Bernoulli Equation, Humidity(Absolute & Relative) , Dew Point (ADP, PDP) Basic, Pneumatic System (Compressor, After coolers, Dryers, Air Tank, Service Unit (FRL), Actuators(single acting, double acting), Valves : 2/2 & 3/2 Valves ,Problems based on valves and actuator to provide employability and entrepreneurship development.

Course Outcomes:

On completion of the course students will be able to

CO 1: Understand the concept of automation, its terminology and basic communication protocol to provide employability.

CO 2: Apply Relay logic for automation nationally to provide employability and entrepreneurship development.

CO 3: Learn about PLC, its operation and application in automation to provide employability and entrepreneurship development.

CO 4: Analyze the industrial sensors, its terminology and how one can interface with PLC to provide skill development, employability and entrepreneurship development.

CO 5: Demonstrate Pneumatic system and its application in industry globally to provide skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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

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CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	1	3	1
CO2	1	3	2
CO3	1	2	3
CO4	2	3	3
CO5	2	3	3

Suggested Readings:

1. Industrial Instrumentation and Control, by Singh, McGraw Hill.
2. Programmable Logic Controllers with Control Logix, by Jon Stenerson, Delmar Publishers, 2009
3. Webb John W. and Reis A. Ronald, "Programmable Logic Controllers Principles and Applications" PHI ,New Delhi, Latest edition
4. Bolton W, "Programmable Logic Controllers" Elsevier India Pvt. Ltd. New Delhi

Website Sources:

1. www.easyengineering.net
2. www.electrical-engineering.net
3. www.lecturenotes.in
4. www.academia.edu
5. www.nptel.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(H): COMPUTER CONTROLLED SYSTEMS

Objective: The purpose of the subject is to provide a thorough background for understanding, analyzing and designing of computer-controlled systems. The objectives include equipping students with the control theory that is relevant to the analysis and design of computer-controlled systems to provide skill development, employability and entrepreneurship development.

Unit I **(08 Sessions)**

Basics of Computer-Aided Process Control:
Role of computers in process control, Elements of a computer aided Process control System, Classification of a Computer–Aided Process Control System Computer Aided Process–control Architecture: Centralized Control Systems, Distributed control Systems, Hierarchical Computer control Systems. Economics of Computer-Aided Process control. Benefits of using Computers in a Process control. Process related Interfaces: Analog Interfaces, Digital Interfaces, Pulse Interfaces, Standard Interfaces for skill development and entrepreneurship development.

Unit II **(08 Sessions)**

Industrial communication System:
Communication Networking, Industrial communication Systems, Data Transfer Techniques, Computer Aided Process control software, Types of Computer control Process Software, Real Time Operating System for skill development and employability.

Unit III **(08 Sessions)**

Process Modelling for computerized Process control:
Process model, Physical model, Control Model, Process modelling. Modelling Procedure: Goals Definition, Information Preparation, Model Formulation, Solution Finding, Results Analysis, Model Validation for skill development, employability and entrepreneurship development.

Unit IV **(08 Sessions)**

Advanced Strategies For Computerised Process control:
Cascade Control, Predictive control, Adaptive Control, Inferential control, Intelligent Control, Statistical control for skill development.

Unit V **(08 Sessions)**

Examples of Computerized Process Control:
Electric Oven Temperature Control, Reheat Furnace Temperature control, Thickness and Flatness control System for metal Rolling, Computer-Aided control of Electric Power Generation Plant for skill development and employability.

Course Outcomes:
On completion of the course students will be able to

CO1: Define the basic concepts and principles of computer control systems at local level for skill development and entrepreneurship development.
CO2: Select appropriate method for system identification for skill development and employability.
CO3: Estimate which method is appropriate for control of a specific system for skill development,employability and entrepreneurship development.
CO4: Compute parameters of digital controllers nationally for typical industrial processes for skill development.
CO5: Demonstrate functionality of computer-controlled system by simulation for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	2	2	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2

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CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	3
CO2	3	3	1
CO3	3	1	1
CO4	3	1	3
CO5	3	3	1

Suggested Readings:

1. S. K. Singh, "Computer Aided Process control", PHI. Reference Books: 1. C. L. Smith, "Digital computer Process Control", Ident Educational Publishers.
2. C. D. Johnson, "Process Control Instrumentation Technology", PHI.
3. Krishan Kant, "Computer Based Industrial Control"
4. Pradeep B. Deshpande & Raymond H. Ash, "Element of Computer Process Control with Advance Control Applications", Instrument Society of America, 1981.
5. C. M. Houpis & G. B. Lamond, "Digital Control System Theory",McGraw Hill.

Website Sources:

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- www.examupdates.in
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- www.notes.specworld.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(I): SMART GRID

Objective: "Smart grid" generally refers to a class of technology used to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation to provide skill development, employability and entrepreneurship development.

Unit I **(08 Sessions)**

Introduction to Smart Grid:
Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid.CDM opportunities in Smart Grid for skill development and entrepreneurship development.

Unit II **(08 Sessions)**

Smart Grid Technologies Part 1:
Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers for skill development and employability.

Unit III **(08 Sessions)**

Smart Grid Technologies Part 2:
Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU) for skill development and employability.

Unit IV **(08 Sessions)**

Microgrids and Distributed Energy Resources:
Concept of microgrid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive
power plants, Integration of renewable energy sources for skill development, employability and entrepreneurship development.

Unit V **(08 Sessions)**

Power Quality Management in Smart Grid:
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring for skill development, employability and entrepreneurship development.

Course Outcomes:
On completion of the course students will be able to

CO1: Describe the communication technologies for smart grid at international level for skill development and entrepreneurship development.
CO2: Describe the information security for smart grid for skill development and employability.
CO3: Recognize infrastructure for smart metering and distribution automation for skill development and employability.
CO4: Describe the tools of Distribution management systems and describe Energy management systems nationally for skill development, employability and entrepreneurship development.
CO5: Describe application of power electronics in Smart grid for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

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(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	2	2	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	3
CO2	3	3	1
CO3	3	3	1
CO4	3	3	3
CO5	3	3	3

Suggested Readings:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication.

Website Sources:

- www.lecturenotes.in
- www.examupdates.in
- www.iare.ac.in
- www.notes.specworld.in

Note: Latest editions of all the suggested readings must be used.

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TMPS204(J): MODELING & SIMULATION OF POWER ELECTRONIC CIRCUITS

Objective: To understand the modeling analysis and performance of electric drive systems fed from PE converters as per system design concepts for skill development and employability.

UNIT-I

INTRODUCTION AND REVIEW OF MODELING OF POWER ELECTRONIC DEVICES (10 Sessions)

Overview and modeling of Power Electronic (PE) devices: Diodes, Thyristors, IGBTs, MOSFET; Comparison of switching characteristics of various devices, Transient and Steady state behavior of PE devices knowledge for better employability in industry.

COMPUTER SIMULATION OF PE CONVERTERS: Challenges in Computer Simulation; Solution techniques for time domain simulation; widely used circuits and/or system oriented simulators.

UNIT-II

SIMULATION OF AC/DC CONVERTERS (06 Sessions)

Modeling of controlled and uncontrolled ac/ dc converters; single-phase & 3- phase ac/dc converters; other topologies for ripple current minimization and power factor improvement.

SWITCH-MODE DC/DC POWER SUPPLIES:

Modeling & Simulation of dc/dc converters such as Buck, Boost, Buck-Boost, Cuk and Full bridge dc/dc Converters understanding for entrepreneurial skill.

UNIT-III

MODELING & SIMULATION OF DC MOTOR DRIVE SYSTEMS (08 Sessions)

Equivalent circuits for DC motors, DC motors with a separately excited field winding, DC servo drives and their control, Adjustable speed dc drives, Effect of discontinuous current, Field weakening effects for skill development.

UNIT-IV

MODELING & SIMULATION OF INDUCTION DRIVE SYSTEMS (10 Sessions)

Induction motor characteristics at rated frequency and rated voltage, simulation of variable frequency voltage source square wave / PWM drive, CSI drive simulation for skill development.

UNIT-V

MODELING&SIMULATIONOF SYNCHRONOUS MOTOR DRIVE SYSTEMS (06 Sessions)

Principles of synchronous motor operation; Brushless dc motor drive operation, synchronous motor servo drive simulation, Load commutated synchronous motor drive knowledge for better employability in industry.

Course Outcomes:

CO1: Modelling and analysis of Power semiconductor devices and Power Electronic converters atinternational level for skill development.

CO2: Knowledge in Power Electronic Converter fed DC & AC drives system and their application to different Industrial needs for skill development.

CO3: Describe the Modelling and analysis of dc motor drive system for employability.

CO4: Describe the Modelling and analysis of Induction drive system globally for employability.

CO5: Describe the Modelling and analysis of synchronous motor drive system for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

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

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(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

CO4	3	3	3	2	2	1	1	1	2
CO5	3	2	3	2	2	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	1
CO5	2	3	1

Suggested Readings:

1. M.B.Patil,V.Ramanarayanan,V.T.Ranganathan,M.C.Chandorkar"SimulationofPowerConverters",1st edition,NarosaPublishers,2010.
2. V.Rajagopalan,"Modeling&SimulationofPEsystems",MarcelDekkarInc

Website Sources:

- www.easyengineering.net
- www.electrical-engineering.net
- www.lecturenotes.in
- www.academia.edu
- www.nptel.ac.in

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TMPS204(K): POWER SYSTEM OPTIMISATION

Objective: Thiscourseaddressesunifiedanduniquemathematicaltreatmentofvariousoptimizationtechniques for Power Systems Engineers for skill development and employability. It covers the theory and applications of NLP, LPP and otherstrategies for solving optimization problem. Examples and applications like minimization of losses, Unitcommitment and active and reactive power dispatch related to power systems operation and control.

UNIT I

INTRODUCTION **(07 Sessions)**

Optimal problem formulation, Design variables, Constraints, Objective function, Variable bounds, Optimization algorithm for skill development.

UNIT II

LINEARPROGRAMMING **(09Sessions)**

Formulation of LPP, Graphical method, Simplex method, The use of artificial variables, Big-M method, Sensitivity analysis and duality theory for skill development and employability.

UNIT III

NON LINEAR PROGRAMMINGI **(07 Sessions)**

Single-Variable optimization algorithms, Optimality criteria, Exhaustive search method, Bounding phase method, Region-Elimination methods, Interval halving method, Fibonacci search method, Golden Section search method, Point-Estimation method, Successive quadratic estimation method, Gradient based methods, Newton-Raphson method, Bisection method, Secant method, Cubic search method for skill development.

UNIT IV

NONLINEARPROGRAMMINGII **(09 Sessions)**

Multivariable optimization algorithms, optimality criteria, Direct search methods, Hooke and Jeeve's method, Powell'sconjugatedirectionmethod,Simplexmethod,Indirectsearch(descent)method,Cauchy's (steepest descent) method, Conjugate gradient (Fletcher-Reeves) method, Newton's method, for skill development and employability.

UNIT V

ECONOMICLOADDISPATCHOFTHERMALGENERATINGUNITS **(08 Sessions)**

Introduction, generator operating cost economic dispatch problem on busbar, optimal generator scheduling, economic dispatch using NR method, Optimal power flow based on Newton's method, Optimal power flow based on gradient method for skill development.

Course Outcomes:

CO1: Learn the unified and exact mathematical basis as well as the general principles of optimization techniques for skill development.

CO2: Understand detailed theoretical and practical aspects of application of optimization techniques at international level for skill development.

CO3: Formulate deterministic mathematical programs and solutions for Power System applications for skill development.

CO4: Determine the operating condition of the power systems, in which optimization of some system variable are obtained for skill development.

CO5: Determine the economic load dispatch of thermal generating units globally for employment.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	2	1	1	1	2
CO2	3	2	2	2	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2
CO4	3	3	3	2	2	1	1	1	2
CO5	3	2	3	2	2	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	1
CO5	2	3	1

Suggested Readings:

1. Power system optimization by kothari,d.p.,dhillon, J.S.,Second Edition,PHI
2. Engineering Optimization:Theory and Practice, Singiresu S.Rao, New Age International.
3. Optimization for Engineering Design by Kalyanmoy Deb PHI publication.
4. Linear Programming in single and multi objective systems by James PIgnizio, Prentice Hall.
5. Operations research an introduction By Hamdy ATAHA Prentice Hall of India.
6. Students are encouraged to read various research papers of peer reviewed journals for application related topics.

Website Sources:

- www.easyengineering.net
- www.electrical-engineering.net
- www.lecturenotes.in
- www.academia.edu
- www.nptel.ac.in

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TMPS204(L): ADVANCED PROTECTING RELAYING

Objective: To impart advanced knowledge in static & microprocessor based protective relaying which have replaced / replacing the old electromagnetic relays and to a certain extent even the static relays. This also includes the protection schemes of long transmission lines for skill development and entrepreneurship development.

UNIT I **(07 Sessions)**

Introduction: Essential qualities of protection, zones of protection, classification of relays, basic protective schemes for skill development and entrepreneurship development.

UNIT II **(08 Sessions)**

Comparators: Transfer impedance, mixing circuits, amplitude and phase comparators and their duality, static realization of amplitude and phase comparators, multi-input comparators for employability and entrepreneurship development.

UNIT III **(07 Sessions)**

Static Relays: Basic construction, input-output devices, merits and demerits of static relays, application of solid state devices for employability and entrepreneurship development.

UNIT IV **(08 Sessions)**

Static Brotection: Over current relaying schemes, differential relaying schemes, distance relaying schemes, power swing, carrier protection of long lines, protection of multi terminal lines, new type of relaying criteria, quadrilateral relay, elliptical relay, restricted distance relays for employability.

UNIT V **(07 Sessions)**

Digital Protection: Concept of digital protection, microprocessor based over current and distance relay schemes, generalized interface for distance relays for employability and entrepreneurship development.

Course Outcomes:

On completion of the course students will be able to

CO1: Understand the basic protective schemes at local level for skill development andemployability.
CO2: Understand the types of Comparators for employability and entrepreneurship development.
CO3: Understand the different types of static relays for employability and entrepreneurship development.
CO4: Understand the various methods of static protection for skill development and employability.
CO5: Understand the concept of digital protection for employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	1	2	3
CO3	1	3	2
CO4	2	3	1
CO5	1	2	3

Suggested Readings:

1. A.R. Van C. Warrington, "Protective Relays- Their theory and practice Vol.I II", John Wiley Sons, 1977
2. B.D. Russel and M.E. Council, "Power System Control and Protection" Academic Press, 1982,
3. T.S.M. Rao, "Power System Protection with Microprocessor Applications" Tata Mc. Graw Hill, 1989
4. B.Ravindranath and M.Chander, "Power System Protection and Switchgear" Wiley Eastern, 1977
5. S.S. Rao, "Switchgear and Protection" Khanna Publishers, 1986
6. B.Ram and D.N. Vishwakarma, "Power system Protection and Switchgear" Tata McGraw Hill, 1995
7. W.A. Elmore (Editor) "Protective Relaying – Theory and applications", Coral Spring Florida. (ABB Power and T&D Co.)
8. A.G. Phadke and J.S. Thorp "Computer based relaying" Research Studies Press John Wiley 1988.

Website Sources:

- www.easyengineering.net
- www.electrical-engineering.net
- www.lecturenotes.in
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- www.nptel.ac.in

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TMPS204(M): SMART SENSORS & INSTRUMENTATION

Objective: To identify and describe present state of energy security and its importance for skill development and employability.

UNIT I

SENSORS & TRANSDUCER: **(08 Sessions)**

Definition, Classification & selection of sensors, Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, Measurement of pressure using LVDT based diaphragm & piezo electric sensor for skill development.

UNIT II

MEASUREMENT OF TEMPERATURE USING THERMISTOR **(10 Sessions)**

Thermocouple & RTD, Concept of thermal imaging, Measurement of position using Hall effect sensors, Proximity sensors: Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors: Ultrasonic & Laser, Level Sensors for skill development.

UNIT III

VIRTUAL INSTRUMENTATION **(07 Sessions)**

Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs, Structures: Case, Sequence & Formula nodes, Need of software based instruments for industrial automation for skill development.

UNIT IV

DATA ACQUISITION METHODS **(06 Sessions)**

Basic block diagram, Analog and Digital IO, Counters, Timers, Types of ADC: successive approximation and sigma-delta ,Types of DAC: Weighted Resistor and R-2R Ladder type, Use of Data Sockets for Networked Communication for skill development and employability.

UNIT V

INTELLIGENT SENSORS **(08 Sessions)**

General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control for skill development.

Course Outcomes:

On completion of the course students will be able to

CO1: Identify and describe different type of transducers and sensors for skill development and employability.

CO2: Identify and describe the basic principle of thermistor and different type of temperature measuring devices nationally for skill development and employability.

CO3: Explain the software LABVIEW for the use of virtual instrumentation and experiments for skill development and employability.

CO4: Describe the data acquisition methods for skill development.

CO5: Discuss the concept of Intelligent sensors at local level for employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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

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TMPS301: SCADA & ENERGY MANAGEMENT SYSTEM

Objective: To learn about the supervisory control and data acquisition control in power system & to learn about the SCADA system and energy management center for skill development.

UNIT I **(08 Sessions)**

SCADA: Purpose and necessity, general structure, data acquisition, transmission & monitoring. general power system hierarchical Structure, Overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels- cables, telephone lines, power line carrier, microwaves, fiber optical channels and satellites knowledge for better employability in industry.

UNIT II **(08 Sessions)**

Supervisory and Control Functions: Data acquisitions, status indications, majored values, energy values, monitoring alarm and event application processing. Control Function: ON/ OFF control of lines, transformers, capacitors and applications in process in industry - valve, opening, closing etc., Regulatory functions: Set points and feedback loops, time tagged data, disturbance data collection and analysis, Calculation and report preparation knowledge for better employability in industry.

UNIT III **(08 Sessions)**

MAN- Machine Communication: Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities for skill development.

UNIT IV **(08 Sessions)**

Data basis- SCADA, EMS and network data basis, SCADA system structure - local system, communication system and central system, Configuration- NON-redundant- single processor, redundant dual processor, multi-control centers, system configuration, Performance considerations: real time operation system requirements, modularization of software programming languages understanding for entrepreneurial skill.

UNIT V **(08 Sessions)**

Energy Management Center: Functions performed at a centralized management center, production control and load management economic dispatch, distributed centers and power pool management understanding for entrepreneurial skill.

Course Outcomes:

CO1: Understand the fundamentals of SCADA for skill development.
CO2: Understand the data acquisition system and control function used in SCADA at international level for skill development, employability and entrepreneurship development.
CO3: Enhance the knowledge in man-machine communication for skill development and employability.
CO4: Conceptualise SCADA system structure, configuration and use of programming in SCADA globally at international level nationally for skill development, employability and entrepreneurship development.
CO5: Understand the energy management system for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	2	2	2	3	2
CO2	3	2	3	2	2	3	3	3	3
CO3	3	2	3	2	2	3	3	2	3
CO4	3	2	3	3	3	3	3	2	2
CO5	3	2	3	2	2	3	3	2	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	2
CO3	2	3	1
CO4	2	3	2
CO5	2	3	2

Suggested Readings:

1. Torsten Cergrell, "Power System Control Technology", Prentice Hall International.
2. George L Kusic "Computer Aided Power System Analysis",, Prentice Hall of India,
3. A. J. Wood and B. Woolenberg, "Power Generation Operation and Control", John Wiley & Sons.
4. Sunil S Rao, "Switchgear Protection & Control System" Khanna Publishers 11th

Website Sources:

- www.sciencedirect.com
- www.iitm.ac.in
- www.nptel.ac.in
- www.springer.com
- www.researchgate.net
- www.academia.edu

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TMPS302: POWER SYSTEM TRANSIENTS

Objective: To learn about the wave equations and its terminologies with its applications & to learn about the high voltage equipment used in power system understanding for entrepreneurial skill.

UNIT I **(08 Sessions)**
Wave terminology, development of wave equations, terminal problems, lattice diagrams, Origin and nature of power system surges, wave shapes, attenuation, effect of shielding by ground wires and masts, tower footing resistance knowledge for better employability in industry.

UNIT II **(08 Sessions)**
Traveling waves, multi-velocity waves, methods of measuring tower footing resistance, voltages across insulator strings, Dynamic over voltages during surges and system faults, system recovery voltage characteristics understanding for entrepreneurial skill.

UNIT III **(08 Sessions)**
Methods of neutral grounding and their effect on system behaviour, Insulation coordination, requirement in surge protection of lines and equipment knowledge for better employability in industry.

UNIT IV **(08 Sessions)**
Impulse generator development, Impulse testing technique, Power frequency h.v. transformers, cascade connection, H.V.D.C. generators, tests with power frequency and d.c. voltages, Large current generating and measurement techniques, Partial discharge testing knowledge for better employability in industry.

UNIT V **(08 Sessions)**
High voltage and high current testing of power equipment, Field investigations, Magnetic links their calibration and mounting, klydenographs, potential dividers and cathodes ray oscillography for skill development.

Course Outcomes:

CO1: Acquire knowledge of the travelling wave in transmission line, lattice diagram and grounding wires at international level for skill development.
CO2: Study about the travelling waves, insulator strings and over voltages during surges for skill development and employability.
CO3: Able to know the method of neutral grounding and other factors associated with neutral grounding nationally for skill development and employability.
CO4: Able to know about the testing and measuring techniques of high voltages and currents for skill development, employability and entrepreneurship development.
CO5: Able to know about high voltage testing equipment for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	2	2	3	3
CO2	3	2	3	2	2	2	2	3	3
CO3	3	2	3	2	2	2	2	3	3
CO4	3	2	3	2	2	2	2	3	3
CO5	3	2	3	2	2	2	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	2
CO5	2	3	1

Suggested Readings:

1. Advance Power System, Stevenson & Grauger Wadha
2. E.w. Kimbark, 'Power System Stability, Vol. I, John Wiley & Sons, 1948-A Book
3. P.C. Magnusswon, 'the Transient Energy Method of Calculating Satability', AIEE Trans,
4. P.D. Aylett, 'Energy Integral Creation of Transient Stability Limits of Power System', Proc IEE
5. O.I. Elgerd, "Electric Energy System Theory" Tata McGraw Hill.
6. P. Kundur, "Power System Stability and Control Mc Graw Hill.

Website Sources:

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- www.nptel.ac.in
- www.routledgehandbooks.com
- www.springer.com
- www.lecturenotes.in

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TMPS303(A):TRANSMISSION AND DISTRIBUTION AUTOMATION

Objective: To learn about power distribution system and substation layout & to learn about SCADA system and its application in electrical system knowledge for better employability in industry.

UNIT I **(08 Sessions)**
Overview of transmission system, SCADA in Power systems, AGC, Energy Management Systems, FACTS, HVDC, Under Frequency Relay (UFR), df/dt control, Islanding. Regional grids, Specifications and details, Functions of the SCADA hierarchical levels in Transmission Master Stations knowledge for better employability in industry.

UNIT II **(08 Sessions)**
Utility distribution system, Types of distribution feeder configurations; Grid network, radial, loop, grounding, Load and fault characteristics, Distribution transformers and regulators, Application of capacitors for distribution system,. Losses and loss reduction in Distribution systems, Over-voltages in Distribution systems for skill development.

UNIT III **(08 Sessions)**
Introduction to Distribution Automation (DA), Constituents of DA, Feeder automation application functions, Outage management, customer information systems, AMI, Distribution load flow & fault location algorithms for distribution system for skill development.

UNIT IV **(08 Sessions)**
Substations, Bus Switching Schemes, Types of substations; GIS, Air Insulated, HV Power Electronic, Smart Grid; Smart Transmission (WAMS, Smart Distribution, Demand Side Integration (Demand Response & Demand Side Management), Energy Storage, Renewable Source Integration knowledge for better employability in industry.

UNIT V **(08 Sessions)**
Substation integration and automaton, Application functions Interface between substation and automation, Open systems, architecture functional data paths, new v/s existing substations understanding for entrepreneurial skill.

Course Outcomes:

CO1: Understand the SCADA system and functions related to that at international level for skill development.
CO2: Understand about the elements of distribution system and their application for skill development, employability and entrepreneurship development.
CO3: Study the distribution automation system and the algorithms for this system for skill development, employability and entrepreneurship development.
CO4: Understand the basic idea of substations and its types and integration of different energy sources at local level for skill development and employability.
CO5: Understand the idea of interfacing the substation and automation for skill development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	2	2	2	3	3
CO2	3	2	3	3	3	3	2	3	3
CO3	3	2	3	3	3	3	2	3	3
CO4	3	2	3	3	3	3	2	3	3
CO5	3	2	3	3	3	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	2
CO3	2	3	2
CO4	2	3	2
CO5	2	3	1

Suggested Readings:

1. Power Distribution Engineering: James J. Burke, Marcel Dekker, Inc.
2. Electric Power Substation Engineering John D. Mc Donald CRC Press, , Taylor and Francis
3. Control and Automation of Electrical Power Distribution systems, James Northcote-Green, R Wilson, CRC Press, Taylor and Francis.

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4. Electric Power Distribution, Automation, Protection and Control, James Momoh, CRC press, Taylor and Francis.

Website Sources:

- www.learnengineering.in
- www.nptel.ac.in
- www.routledgehandbooks.com
- www.springer.com
- www.lecturenotes.in
- www.researchgate.net

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TMPS303(B): POWER SYSTEM RELIABILITY

Objective: To learn about the basics of probability theory & its implementation in power system & to learn about the composite, complex and parallel networks and analyze their behavior understanding for entrepreneurial skill.

(08 Sessions)

UNIT I

Basics of Probability theory & Distribution: Basic probability theory, rules for combining probabilities of events, Bernoulli's trials, probabilities density and distribution functions binomial distribution, expected value and standard deviation of binomial distribution.

Network Modeling and Reliability Analysis: Analysis of Series, Parallel, Series-Parallel networks, complex networks, decomposition method understanding for entrepreneurial skill.

(08 Sessions)

UNIT II

Reliability functions : Reliability functions f(t), F(t), R(t), h(t) and their relationships, exponential distribution, Expected value and standard deviation of exponential distribution, Bath tub curve, reliability analysis of series parallel networks using exponential distribution ,reliability measures MTTF, MTTR, MTBF for skill development.

(08 Sessions)

UNIT III

Markov Modeling : Markov chains, concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities, Markov processes one component repairable system , time dependent probability evaluation using Laplace transform approach, evaluation of limiting state probabilities using STPM, two component repairable models knowledge for better employability in industry.

Frequency & Duration Techniques : Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one , two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering of merged states understanding for entrepreneurial skill.

(08 Sessions)

UNIT IV

Generation System Reliability Analysis : Reliability model of a generation system, recursive relation for unit addition and removal, load modeling, Merging of generation load model ,evaluation of transition rates for merged state model, cumulative Probability, cumulative frequency of failure evaluation, LOLP, LOLE knowledge for better employability in industry.

(08 Sessions)

UNIT V

Composite Systems Reliability Analysis: Decompositions method, Reliability Indices, Weather Effects on Transmission Lines to develop skill.

Distribution System and Reliability Analysis: Basic Concepts, Evaluation of Basic and performance reliability indices of radial networks for skill development.

Course Outcomes:

CO1: Understand the probability theory functions and analysis of different networks for skill development.
CO2: Study about reliability functions and their applications at international level for skill development, employability and entrepreneurship development.
CO3: Understand the limiting state probabilities with Markov modeling methods and frequency and duration concept for skill development.
CO4: Learn about generation system reliability analysis for skill development and employability.
CO5: Study the composite system reliability analysis methods nationally for skill development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	3	3	3	2	2	2
CO2	3	2	3	3	3	3	2	2	2
CO3	3	2	3	3	3	3	3	2	2
CO4	3	2	3	3	3	3	3	2	2
CO5	3	2	3	3	3	3	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	2
CO3	3	2	1

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CO4	3	3	1
CO5	2	3	1

Suggested Readings:

1. Reliability Evaluation of Engg. System – R. Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Evaluation of Power systems – R. Billinton, R.N.Allan, Pitman Advance Publishing Program, NY.
3. An Introduction to Reliability and Maintainability Engineering.- Charles E. Ebeling, TATA Mc Graw – Hill.

Website Sources:

- www.learnengineering.in
- www.nptel.ac.in
- www.routledgehandbooks.com
- www.springer.com
- www.lecturenotes.in

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TMPS303(C): ADVANCED CONTROL SYSTEM

Objective: To understand the signals for controlling the electrical system & to understand the stability analysis and transient response of various systems knowledge for better employability in industry.

(08 Sessions)

UNIT I:
STATE VARIABLE ANALYSIS: Concept of state – State Variable and State Model State models for linear and continuous time systems – Solution of state and output equation – controllability and observability - Pole Placement – State observer Design of Control Systems with observers for skill development.

(08 Sessions)

UNIT II:
PHASE PLANE ANALYSIS: Features of linear and non-linear systems - Common physical non linearities – Methods of linearising non-linear systems - Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method for better employability in industry.

(08 Sessions)

UNIT III:
DESCRIBING FUNCTION ANALYSIS: Basic concepts, derivation of describing functions for common non-linearity – Describing function analysis of non-linear systems – Conditions for stability – Stability of oscillations for skill development.

(08 Sessions)

UNIT IV:
STABILITY ANALYSIS: Introduction – Liapunov's stability concept – Liapunov's direct method – Lure's transformation – Aizerman's and Kalman's conjecture – Popov's criterion – Circle criterion for skill development.

(08 Sessions)

UNIT V:
OPTIMAL CONTROL: Introduction -Decoupling - Time varying optimal control – LQR steady state optimal control – Optimal estimation – Multivariable control design for skill development.

Course Outcomes:

CO1: Develop the mathematical model of the physical systems globally for skill developmentand employability.
CO2: Analyze the stability of the closed and open loop systems for skill developmentand employability.
CO3: Design the various kinds of compensator for skill development, employability and entrepreneurship development.
CO4: Develop and analyze state space models at international level for skill development.
CO5: Ability to formulate transfer function for given control system problems for skill developmentand employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	2
CO4	3	2	1
CO5	2	3	1

Suggested Readings:

1. I.J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2003.
2. Ashish Tewari, 'Modern control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.
3. M.Gopal, Modern control system theory, New Age International Publishers, 2002.

Website Sources:

- www.nptel.ac.in
- www.routledgehandbooks.com
- www.springer.com

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TMPS303(D): ADVANCED DIGITAL SYSTEM

Objective: To learn about digital communication and its different types of coding & to learn about multiplexing in electronic systems understanding for entrepreneurial skill.

(08 Sessions)

UNIT-I

Elements of Digital Communication and Information Theory: Model of a Digital Communication, System, Probability Theory and Random Variables , Logarithmic Measure of Information, Entropy and Information and Information Rate, Conditional Entropy and Redundancy, Source Coding, Fixed and Variables Length Code Words, Source Coding Theorem, Prefix Doing and Kraft Inequality, Shannon-Fano and Huffman Coding knowledge for better employability in industry.

(08 Sessions)

UNIT-II

Digital Base band Transmission: PCM Coding, DM, DPCM, ADCM, Data Transfer Rate, Line Coding and its Properties and its Properties, NRZ &RZ &RZ Types, Signaling Format For Unipolar, Polar, Bipolar (AMI) & Manchester Coding and Their Power Spectra (No Derivation) Matched Filter Receiver, Derivation of Its Impulse Response and Peak Pulse Signal to Noise Ratio. Correlation Detector Decision Threshold and Error Probability For Binary, Unipolar (ON-OFF) Signaling, ISI, Nyquist Criterion For Zero ISI & Raised Cosine Spectrum knowledge for better employability in industry.

(08 Sessions)

UNIT-III

Digital Modulation Techniques: Gram-Schmidt Orthgonalization Procedure, Types of Digital Modulation, Wave forms for Amplitude, Frequency and Phase Shift Keying, Method of Generation and Detection of Coherent && Non-Coherent Binary ASK, FSK & PSK Differential Phase Shift Keying, Quadrature Modulation Techniques QPSK, Probability of Error and Comparison of Various Digital Modulation Techniques to develop skill.

(08 Sessions)

UNIT-IV

Digital Multiplexing: Fundamentals of Time Division Multiplexing, Electronic Commutator, Bit, Byte Interleaving T1 Carrier System, Synchronization and Signaling of T1, TDM, PCM Hierarchy, T1 toT4 PCM TDM System (DS1 to DS4 Signals) understanding for entrepreneurial skill.

(08 Sessions)

UNIT-V

Error Control Coding: Error Free Communication Over a Noize Channel, Hamming code, Relation Between Minimum Distance and Minimum Distance Error Correcting Capability, Linear Block Codes, Encoding and Syndrome Decoding, Cyclic Codes, Tree diagram state diagram and Trellis Diagram, Viterbi and Sequential Decoding Comparison of performance knowledge for better employability in industry.

Course Outcomes:

CO1: Apply the knowledge of statistical theory of communication and explain the conventional digital communication system nationally for skill development.

CO2: Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise for skill development, employability and entrepreneurship development.

CO3: Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code for skill development.

CO4: Describe and analyze the digital communication system with spread spectrum modulation at international level for skill development.

CO5: Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for digital modulators and demodulator using hardware components and communicationsystems using CAD tool for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	3	3	3	3	2	2	2
CO2	2	3	3	3	3	3	2	2	2
CO3	2	3	3	3	3	3	2	2	2
CO4	2	3	3	3	3	3	2	2	2
CO5	2	3	3	3	3	3	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	2
CO3	2	3	1
CO4	3	2	1
CO5	2	3	2

Suggested Readings:

1. Haykin, Simon / "Communication System" / John Wiley /4th Ed.
2. Singh, R.P. & Sapre, S.D. /"Communication Systems: Analog &Digital" /Tata McGraw-Hill.
3. Lathi, B.P. / "Modern Digital &Analog Communication System" /Oxford University Press.
4. Simon Haykin/ "Prinicples of Communication Systems"/ Tata McGraw-Hill

Website Sources:

- www.easyengineering.net
- www.nptel.ac.in
- www.lecturenotes.in
- www.scribd.com
- www.ocw.mit.edu

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TMPS303(E): POWER SYSTEM MODELING

Objective: To describe characteristics and appropriate mathematical models for representations of power system components such as synchronous machine, transmission line, transformer, induction motor, excitation systems and non-electrical components in power system dynamic studies for skill development, employability and entrepreneurship development. Review of steady state and transient performance characteristic of synchronous machine.

UNIT I **(08 Sessions)**

Modeling of Power System Components:
The need for modeling of power system, different areas of power system analysis. Models of nonelectrical components like boiler, steam & hydro-turbine & governor system. Transformer modeling such as auto-transformer, tap-changing & phase shifting transformer for skill development and employability.

UNIT II **(08 Sessions)**

Synchronous machine modeling
Model required for steady-state analysis. The development of model required for dynamic studies. The current & flux linkage models using Park's transformation leading to simulation as linear model for skill development and employability.

UNIT III **(08 Sessions)**

Analysis of synchronous machine modeling
Synchronous machine connected to an infinite bus, its simulation for steady-state condition for employability.

UNIT IV **(08 Sessions)**

Excitation systems
Simplified view of excitation control.Excitation configuration, primitive systems, Definitions of voltage response ratio & exciter voltage ratings for employability and entrepreneurship development.

UNIT V **(08 Sessions)**

Excitation system modeling
Excitation control systems using dc generator exciter, alternator-rectifier, alternator SCR, and voltage regulators such as electro-mechanical and solid state. Modeling of excitation systems for skill development, employability and entrepreneurship development.

Course Outcomes:
On completion of the course students will be able to

CO1: Develop power system components modeling and analyze their performance for skill development and employability.
CO2: Develop modeling of synchronous machine and analyze its performance globally at for skill development and employability.
CO3: Perform steady state and dynamic analysis on simulation models for skill development, employability and entrepreneurship development.
CO4: Understand configuration and functioning of synchronous machine excitation system for skill development, employability and entrepreneurship development.
CO5: Develop excitation system components modeling and analyze their performance at international level for employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	1	3	2
CO4	2	3	2
CO5	2	3	2

Suggested Readings:

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. R.Ramunujam," Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2009.
3. Electric Power Systems: B.M. Weddy and B.J. Cory, John Wiely and Sons, Fourth adition (2002).
4. Power System Analysis and Design :J. Duncan Glover, MulukutlaS. Sarma, Thomson Brooks/cole/ Third Edition (2003)

Website Sources:

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- www.electrical-engineering.net
- www.lecturenotes.in
- www.academia.edu
- www.nptel.ac.in

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TMPS303(F): CONTROL SYSTEM DESIGN AND ESTIMATION

Objective: To provide knowledge on design in state variable form, phase plane analysis and study the design of optimal controller and design of optimal estimator including Kalman Filter for skill development and employability.

UNIT I **(08 Sessions)**
STATEVARIABLEDESIGN
Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition for Arbitrary Pole-placement- pole placement Design- design of state Observers- separation principle-servo design:-State Feedback with integral control for skill development and employability.

UNIT II **(09 Sessions)**
PHASEPLANEANALYSIS
Features of linear and non-linear systems - Common physical non-linearities – Methods of linearization Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits –Phase plane analysis of linear and non-linear systems–Isocline method knowledge for better employability.

UNIT III **(08 Sessions)**
DESCRIBINGFUNCTIONANALYSIS
Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems –limit cycles–Stability of oscillations for skill development and employability.

UNIT IV **(07 Sessions)**
OPTIMALCONTROL
Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation –Application examples knowledge for better employability.

UNIT V **(06 Sessions)**
OPTIMALESTIMATION
Optimalestimation–KalmanBucyFilter-Solutionbydualityprinciple-Discretesystems-KalmanFilter-Application examples for skill development and employability.

Course Outcomes:
On completion of the course students will be able to
CO1: Identify and design the state variable in different condition at local level for skill development and employability.
CO2: Describe the basic principles and methodologies of phase plane analysis for skill development and employability.
CO3: Describe function analysis methods for skill development.
CO4: Describe Optimal control methods at international level for skill development.
CO5: Analyze the data collected during performance evaluation and optimal estimation for employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	2	1	1	1	2
CO2	3	2	2	2	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2
CO4	3	3	3	2	2	1	1	1	2
CO5	3	2	3	2	2	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	1
CO5	2	3	1

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Suggested Readings:

1. MohandasK.P.,"ModernControlEngineering",SanguineTechnicalPublishers,2006
2. ThalerG.J.,"AutomaticControlSystems",JaicoPublishingHouse,1993
3. Gopal,M.Moderncontrolsystemtheory,NewAgeInternationalPublishers,2002
4. OgataK.,,,ModernControlEngineering",4thedition,PHI,NewDelhi,2002.
5. GladT.andLjungL."Controltheory–MultivariableandNon-linearmethods",Taylor&Francis,2002
6. NaiduD.S.,"OptimalControlSystems"FirstIndianReprint,CRCPress,2009.

Website Sources:

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- www.electrical-engineering.net
- www.lecturenotes.in
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- www.nptel.ac.in

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TMPS303(G): SMART GRID DESIGN AND ANALYSIS

Objective: This course is designed for the development the behaviour of existing electrical grid changes very fast and requires dynamic platforms to address the peculiarities related to increased penetration from renewable energy sources, possible inclusion of electric vehicles, ensuring energy security, open access and deregulationto get knowledge for better employability in industry.

(08 Sessions)

UNIT-I

Introduction to Smart Grid - Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India for skill development.

(07 Sessions)

UNIT-II

Smart Grid Architecture – Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition system, advanced metering infrastructure. The fundamental components of Smart Grid designs for better employability in industry, Transmission Automation, Distribution Automation, Renewable Integration

(08 Sessions)

UNIT-III

Tools and Techniques for Smart Grid - Computational Techniques – Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch – Computational Intelligence Techniques – Evolutionary Algorithms in power system – Artificial Intelligence techniques and applications in power system for entrepreneurship & employability.

(08 Sessions)

UNIT-IV

Communication Technologies in Smart Grid - Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchro- Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid for better employability in industry.

(07 Sessions)

UNIT-V

Smart-cities - Smart city pilot projects, essential elements of smart cities, active distribution networks, microgrids, distribution system automation, Reliability and resiliency studies, decentralized operation of power network for skill development and employability.

Course Outcomes:

On completion of this course, the students will be able to:

CO1: Understand the features of Smart Grid at local level for skill development, employability and entrepreneurshiip development.

CO2: Assess the role of automation and digitization in Transmission and Distribution for skill development.

CO3: Apply different types of Grid techniques to design the optimum output for skill development.

CO4: Analyse Smart grids and Distributed energy resources (DER) with evolutionary algorithms globally for skill development and employability.

CO5: Investigate operation and the importance of data acquisition devices and their location forVoltage and Frequency control for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	2
CO2	2	1	1
CO3	2	2	1
CO4	3	2	2
CO5	2	3	1

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Suggested Readings:

1. Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, CRC Press, 2013, 1st Edition.
2. Renewable and Efficient Electric Power System, G. Masters, Wiley–IEEE Press, 2013, 2nd Edition.
3. Synchronized Phasor Measurements and their Applications, A.G. Phadke and J.S. Thorp, Springer, 2017, 2nd Edition.
4. Wind Power in Power Systems, T. Ackermann, Hoboken, N J, USA, John Wiley, 2012, 2nd Edition

Website Sources:

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- www.nptel.ac.in
- www.lecturenotes.in
- www.electrical-engineering-portal.com
- www.electrical4u.com

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TMPS303(H): ADVANCED DIGITAL COMMUNICATION

Objective: To understand the basics of signal-space analysis and digital transmission, to understand the coherent and noncoherent receivers and its impact on different channel characteristics and to understand Orthogonal Frequency Division Multiplexing. To understand the different block coded and convolutional coded digital communication systems to get knowledge for better employability in industry.

(08 Sessions)

UNIT-I
COHERENT AND NON-COHERENT COMMUNICATION- Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK--BER Performance Analysis. Carrier Synchronization- Bit synchronization for better understanding for entrepreneurial skill.

(07 Sessions)

UNIT-II
EQUALIZATION TECHNIQUES– Band Limited Channels for better employability in industry - ISI – Nyquist Criterion-Controlled ISI-Partial Response signals- Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

(08 Sessions)

UNIT-III
BLOCK CODED DIGITAL COMMUNICATION-Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes for entrepreneurship & employability.

(08 Sessions)

UNIT-IV
CONVOLUTIONAL CODED DIGITAL COMMUNICATION-Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding for better employability in industry.

(07 Sessions)

UNIT-V
OFDM- Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; OFDM signal processing; Peak Power Problem: PAP reduction schemes- Clipping, Filtering, Coding and Scrambling for skill development and employability.

Course Outcomes:
On completion of this course, the students will be able to:

CO1: Develop the ability to understand the concepts of signal space analysis coherent and noncoherent receivers at international level for skill development, employability and entrepreneurship development.
CO2: Comprehend the generation of OFDM signals and the processing of the signals for skill development.
CO3: Possess knowledge on different block codes and convolutional codes for skill development.
CO4: Conceptually appreciate different Equalization techniques globally for skill development and employability.
CO5: Develop the ability to understand the generation of sub-carriers for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	3	2	1
CO4	3	2	2
CO5	2	3	1

Suggested Readings:

1. M.K.Simon, S.M.Hinedi and W.C.Lindsey, Digital communication techniques; Signalling and detection, Prentice HallIndia,NewDelhi.1995.
2. Simon Haykin, Digital communications, John Wiley and sons, 1998
3. Bernard Sklar., 'Digital Communications', second edition, Pearson Education, 2001.
4. John G. Proakis., 'Digital Communication', 4 th edition, Mc Graw Hill Publication, 2001

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TMPS303(I): OPTIMIZATION TECHNIQUES

Objective: To develop a knowledge in the field of optimization techniques their basic concepts, principles, linear programming and queuing theory for skill development and employability.

Unit I

Introduction to Optimization: **(09 Sessions)**

Engineering application of Optimization, Statement of an optimization problem, Optimal problem formulation, Classification of optimization problem, Optimum design concepts: Definition of Global and Local optima using basic calculus concepts; Classical Optimization Techniques for skill development and employability: Unconstrained Optimization - Single variable optimization, Constrained multivariable optimization with equality constraints - Lagrange multipliers method, Constrained multivariable optimization with inequality constraints - Kuhn-Tucker conditions.

Unit II

Linear Programming: **(08 Sessions)**

Standard form of linear programming, Graphical solution, Simplex method, Big-M method, Duality theory, Decomposition principle, Transportation problem using North-West Corner rule and Least cost rule for skill development and employability.

Unit III

Non-Linear Programming: **(09 Sessions)**

Standard form of non-linear programming, One–Dimensional Minimization Methods - Unimodal function, Dichotomous search, interval halving method; Unconstrained Optimization Techniques - Univariate method, Steepest descent method; Constrained Optimization Techniques - Interior Penalty function method, Exterior penalty function method for skill development and employability.

Unit IV

Simulation: **(09 Sessions)**

Definition, types of simulation, General process of simulation, advantages & disadvantages of simulation. Project Management Techniques: PERT and CPM Modern methods of Optimization: Genetic algorithm, working principle, fitness function, GA operators – crossover & mutation, comparison of GA with traditional methods for skill development, employability and entrepreneurship development.

Unit V

Case study (algorithm only): **(08 Sessions)**

Economic load scheduling of power plant (without considering losses), maintenance scheduling of machines in manufacturing industry, fuzzy logic based speed control of DC machines for skill development and employability.

Course Outcomes:

On completion of the course students will be able to

CO1: Understand the importance of optimization techniques in engineering applications for skill development and employability.

CO2: Learn optimization methods for solving linear programming problems at local level for skill development and employability.

CO3: Learn optimization methods for solving nonlinear programming problems for skill development and employability.

CO4: Be aware of the concept of simulation and modern methods of optimization for skill development, employability and entrepreneurship development.

CO5: Apply optimization techniques to electrical engineering problems globally for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	2
CO5	2	3	2

Suggested Readings:

1. S.S.Rao,"Optimization - Theory and Applications", Wiley-Eastern Limited.
2. D.E. Goldberg,"Genetic Algorithm in Search Optimization and Machine Learning ", Addision-Wesley Publication, 1989
3. Kwang Y. Lee, Mohamed A. El-Sharkawi, "Modern heuristic optimization techniques, Theory and applications to power systems", Wiley-Interscience

Website Sources:

- www.easyengineering.net
- www.electrical-engineering.net
- www.lecturenotes.in
- www.academia.edu
- www.nptel.ac.in

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TMPS303(J): ADVANCED ENERGY SYSTEM MANAGEMENT

Objective: To emphasize the important problem of integrated energy management for skill development, employability and entrepreneurship development.

UNIT I **(09 Sessions)**

Energy Resources: Perspective on energy resources, Utilization and demand projections, Energy resource definition & classification, Causes of Energy scarcity and social disparity, Energy as a parameter of Techno-Socio Economic development, Factors solving the energy crunch, Energy system model – Description & qualitative analysis, Acceptability Index and its significance for skill development and employability .

UNIT II **(09 Sessions)**

Concept Of Energy Management: Definition and Significance, Benefits, Classifications, Key Issues - Techno economic Issues, Programmatic and Institutional Issues, Energy management implementation criteria for skill development, employability and entrepreneurship development, Approaches of Energy management: Procedural Energy Management Opportunities (PEMOS), Equipment Modifications, Additions or Replacement EMOS (Retrofit EMOS), Research and Development and New Installation (R&DEMOS), Resource or Fuel Substitution (Substitution EMOS), Examples for each. Comparative features.

UNIT III **(09 Sessions)**

General Principles Of Energy Management: Proper/Optimal Control, Optimize Capacity, Reduce Loads, More Efficient Equipment and Appliances, More Efficient Processes, Employ Special Techniques to Reduce Losses, Energy Containment, Cascade Energy Use, Energy Conversion & storage Principle. (Introduction with examples & comparative features) for skill development and employability.

UNIT IV **(09 Sessions)**

Energy Efficiency Analysis: Different types of losses involved in Process and industry, First Law of Efficiency, simple examples & calculations, Limitation, Efficiency and its significance Second law of Efficiency – Quality of Energy form, Available work, Coefficient of Performance (COP), Effectiveness, Simple calculations for skill development and employability.

UNIT V **(09 Sessions)**

Energy Economics: Comparison of alternatives options; Simple economic calculations, Life cycle casting, Life cycle savings, payback period and return of investments. Break Even Analysis & its limitations, Benefit / Cost analysis, Time value of money , Calculation of present worth & present worth factor, Simple calculation of Payback period, solar energy economics for skill development and employability.

(I) Case study:-Electric loads- Lighting, Motor and Power; Fluid Flow Control- pump, fan, blower, and compressor; Residential colony.

(II) Planning For Energy Management- Planning phases; Initial phase decision to Undertake Program, Commitment by Management, Statement of Objectives. Analysis and simulation phase- Database and information collection, Energy Audit, Computer Analysis and Simulation. Implementation phase- implementation, Monitoring of program, periodic review, Modification, and optimization.Modeling and parameter for planning for skill development and employability.

Course Outcomes:

On completion of the course students will be able to

CO1: Understand the different energy resources at local level for skill development and employability.
CO2: Understand the concept of energy management for skill development and employability.
CO3: Understand the general principles of energy management for skill development and employability.
CO4: Understand the analysis of energy efficiency for skill development and employability.
CO5: Understand the case study and planning of energy management globally for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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

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CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	1
CO5	2	3	1

Suggested Readings:

1. C.B. Smith ,'Energy Management Principles' Pergammon Press, 1981
2. Y. Y. Haimes (ed), 'Energy Auditing and Conservation'. Hemisphere Publishing Corporation, New York, 1980.
3. J. S. Hsieh, 'Solar Energy Engineering'. Prentice Hall Inc, New Jersey, 1981.
4. D. Millington.'System Analysis and Design for Computer Applications'. Affiliated East West Press Pvt Ltd, New Delhi, 1981.

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- www.nptel.ac.in

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TMPS303(K): NON CONVENTIONAL ENERGY SOURCES & ENERGY CONVERTERS

Objective: This course is designed for the development of self study and seminar delivery skills in Nonconventional Energy Sources knowledge for better employability in industry.

UNIT I **(08 Sessions)**

Introduction - Various non-conventional energy resources-importance, classification, relative merits and demerits for skill development.

UNIT II **(07 Sessions)**

Solar Energy – Solar photovoltaics: Introduction, solar radiation & its relation with photovoltaic effect. Solar cell material; silicon mono & poly crystalline, raw material other than silicon. Different types of solar cell construction and design, flat plate arrays:-optimal system sizing & protection. Photovoltaic concentration, photovoltaic systems-standalone, PV-hybrid, grid-interactive. Stationary and tracking panels, maximum power point tracking, energy storage, converter & inverter systems & their control for better employability in industry, Transmission Automation, Distribution Automation, Renewable Integration

UNIT III **(08 Sessions)**

Solar thermal - Thermal characteristics of solar radiation, solar collectors:-materials, types, focussing. Solar thermal power plant-layout and arrangement, solar cooling, recent developments for entrepreneurship & employability. Application-water pumping & power plants, cost & economics, recent developments.

UNIT IV **(08 Sessions)**

Wind Energy - Wind power and its sources, site selection criterion, wind characteristics, momentum theory, Classification of wind machines. Wind mills-different design & their control, wind generators different types, wind farms & grid. Wind generation in India. Issues of wind integrations-intermittent supply, economics, governmental regulations & subsidies. Wind penetration & its effects, economic issues, recent developments, international scenario for better employability in industry.

UNIT V **(07 Sessions)**

Fuel Cell - Basic construction & principle of operation of fuel cell, Gibbs-Helmholtz equations, thermodynamic free energy and conditions of equilibrium, classification of fuel cell, different types of fuel cell:-direct type-low or medium temperature alkaline type, low temperature ion exchange membrance, direct high temperature fuel cells, Redox fuel cells, operation characteristic. Fuel cell power plants & its integration with wind and solar photovoltaic systems, smart grids. Applications, recent developments for skill development and employability.

Course Outcomes:

On completion of this course, the students will be able to:

CO1: Understand of renewable and non-renewable sources of energy for skill development, employability and entrepreneurship development.

CO2: Gain knowledge about working principle of various solar energy systems at international level for skill development.

CO3: Develop capability to do basic design of bio gas plant for better employability in industry.

CO4: Understand the application of wind energy and wind energy conversion system for skill development and employability.

CO5: Understand the different types of fuel cell and smart grid energy nationally for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	2	3	1
CO3	3	2	1
CO4	2	3	1

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CO5	3	2	1

Suggested Readings:

1. F.C. Treble, "Generating electricity from sun", pergamon press, U K
2. Tapan Bhattacharya, "Terrestrial solar photovoltaics", Narosa publishing house, New Delhi, 1998.
3. G.D. Rai, "Non-conventional energy resources", Khanna Publishers, New Delhi, 2003.
4. S.P. Sukhatme, "Solar energy principles of thermal collection and storage", McGraw-Hill publishing company, limited, New Delhi, 1984.
5. C.J. Winter, L.C. Sizmann and Van-Hull, "Solar power plants", Sringer-Verlog publishers, 1991.

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- www.electrical-engineering-portal.com
- www.electrical4u.com

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TMPS303(L): POWER SYSTEM PLANNING

Objective: To study about the power system planning & to learn about the different kinds of planning used in power system to provide employability & skills.

(08 Sessions)

UNIT I

Objectives of planning – Long and short term planning. Load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting for skill development.

(07 Sessions)

UNIT II

Load forecasting Objectives of forecasting – Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

(08 Sessions)

UNIT III

Expansion planning for better employability in industry - Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

(08 Sessions)

UNIT IV

Distribution system planning overview - Introduction, sub transmission lines and distribution substations-Design primary and secondary systems distribution system protection and coordination of protective devices to develop skill.

(07 Sessions)

UNIT V

Demand-Side Planning- Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit for understanding for entrepreneurial skill.

Course Outcomes:

On completion of this course, the students will be able to

CO1: Understand various forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools at international level for skill development, employability and entrepreneurship development.

CO2: Discuss methods to mobilize resources to meet the investment requirement for the power sector for skill development.

CO3: Discuss expansion of power generation and planning for system energy in the country,evaluation of operating states of transmission system, their associated contingencies and the stability of the system for skill development.

CO4: Discuss principles of distribution planning, supply rules, network development and the system studies globally for skill development and employability.

CO5: Discuss planning and implementation of electric –utility activities, market principles and the norms framed by CERC for online trading and exchange in the interstate power market for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	1
CO3	3	2	1
CO4	3	2	1
CO5	2	3	1

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Suggested Readings:

1. R.L. Sullivan, "Power System Planning", Tata McGraw Hill Publishing Company Ltd, 2012.
2. X. Wang & J.R. McDonald, "Modern Power System Planning", McGraw Hill Book Company,1994.
3. T. Gonen, "Electrical Power Distribution Engineering", McGraw Hill Book Company, 1986

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TMPS 303(M): ADVANCED ELECTRIC AND HYBRID VEHICLES

Objective: To describe the configuration and performance of Electric vehicles & also discuss energy storage devices for skill development, employability and entrepreneurship development.

UNIT I
ELECTRIC VEHICLES **(08 Sessions)**

Introduction, Layout of an Electric Vehicle, Performance of Electric Vehicles a) Traction Motor Characteristics b) Tractive Effort and Transmission Requirements c) Vehicle Performance , Energy Consumption, Advantages and Limitations, Specifications, System Components, Electronic Control System. for skill development, employability and entrepreneurship development.

UNIT II
HYBRID VEHICLES **(08 Sessions)**

Concepts of Hybrid Electric Drive Train, Architectures of Series Hybrid Electric Drive Trains, Architectures of Parallel Hybrid Electric Drive Trains, Merits and Demerits, Series Hybrid Electric Drive Train Design, Parallel Hybrid Electric Drive Train Design for skill development, employability and entrepreneurship development.

UNIT III
FUEL CELLS & SOLAR CARS **(08 Sessions)**

Photovoltaic Cells, Tracking, Efficiency, Solar Cars, Fuel Cells - Construction & Working, Equations, Possible Fuel Sources, Fuel Reformer, Design, Cost Comparison for skill development, employability and entrepreneurship development.

UNIT IV
ELECTRIC PROPULSION SYSTEM AND MOTOR CONTROL SYSTEM **(10 Sessions)**

DC Motors Characteristics, Speed and Torque Control, Regenerative Braking. AC Motors Characteristics, Speed and Torque Control.PM- BLDC Motors Characteristics, Speed and Torque Control. Reluctance Motors Characteristics, Speed and Torque Control, Regenerative Braking for skill development, employability and entrepreneurship development.

UNIT V
ENERGY STORAGES & GENERATORS **(08 Sessions)**

Electrochemical Batteries: Types of Batteries, Lead-Acid Batteries, Nickel Based Batteries, Lithium Based Batteries, Electro Chemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency, Ultra Capacitors, DC Generators, AC Generators, Voltage and Frequency Regulations for skill development, employability and entrepreneurship development.

Course Outcomes:

On completion of the course students will be able to

CO 1: Describe the configuration and performance of Electric vehicles at international level for skill development, employability and entrepreneurship development.
CO 2: Design the structure of Hybrid Electric Vehicle for skill development, employability and entrepreneurship development.
CO 3: Describe the operation of Fuel Cells for skill development, employability and entrepreneurship development.
CO 4: Explain Electric propulsion system and Motor control systems internationally for skill development, employability and entrepreneurship development.
CO 5: Discuss energy storage devices and generators for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	1	1	1	2
CO2	3	3	3	3	3	1	1	1	2
CO3	3	3	3	3	3	1	1	1	2
CO4	3	3	3	3	3	1	1	1	2
CO5	3	3	3	3	3	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	2
CO2	2	3	2
CO3	2	3	2
CO4	2	3	2
CO5	2	3	2

Suggested Readings:

1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design", CRC Press, 2004.
2. James Larminie and John Loury, "Electric Vehicle Technology – Explained", John Wiley & Sons Ltd, 2003.
3. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth – Heinemann, 2002.
4. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002.
5. Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design", Butterworth – Heinemann, 2001.
6. Iqbal Husain, "Electric and Hybrid Vehicles- Design Fundamentals" CRC Press, 2011.

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