ANNEXURE – I

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Shahbad Daulatpur, Main Bawana Road, Delhi-42

(Academic-PG)

Scheme for Full Time M. Tech.PSY as per NEP-2020

SEMESTER I					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
PSY501	Advanced Power System Analysis	4	3-0-2	24	500-599*
PSY503	Power System Dynamics & Stability	4	3-0-2		
PSY505	Power Electronics for Renewable Energy	4	3-1-0		
PSY507	Flexible AC Transmission System	4	3-1-0		
	Departmental Elective 1	4			
PSY511	Advanced Control System		3-1-0		
PSY513	Power System Reliability		3-1-0		
PSY515	Smart Grid & Microgrid		3-1-0		
PSY517	Soft computing Techniques		3-1-0		
PSY519	Power Quality		3-1-0		
	Self-Study**	2	-		
PSY551	Seminar				
PSY553	MOOC				
	Skill Enhancement Course 1***	2			
PSY541	PCB design		0-0-4		
PSY543	Professional software		1-0-2		
	Audit Course	0			
UEC501	English for Research Paper Writing		2-0-0		
UEC503	Disaster Management		2-0-0		
UEC505	Sanskrit for Technical Knowledge		2-0-0		
UEC507	Value Education		2-0-0		
UEC509	Constitution of India		2-0-0		
UEC511	Pedagogy Studies		2-0-0		
UEC513	Stress Management by Yoga		1-0-2		
UEC515	Personality Development through Life Enlightening Skills		2-0-0		
SEMESTER II					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**

PSY502	Advanced Power System Protection	4	3-0-2	24	500-599*
PSY504	Power System operation & Control	4	3-0-2		
	Departmental Elective 2	4			
PSY520	PMU&Wide area Monitoring System		3-1-0		
PSY522	HVDC Transmission		3-1-0		
PSY524	EHVAC Transmission		3-1-0		
PSY526	Power System Transients		3-1-0		
PSY528	Grid Integration of Renewable Energy System		3-1-0		
	Departmental Elective 3	4			
PSY530	Optimization Techniques		3-1-0		
PSY532	Forecasting Techniques		3-1-0		
PSY534	Electricity Market Regulations & Trading		3-1-0		
PSY536	Power System Planning		3-1-0		
PSY538	Substation Automation		3-1-0		
UCC502	Research Methodology and IPR	4	3-1-0		
	Skill Enhancement Course 2 /Industrial Training	4			
PSY540	Industrial Training		0-0-8		
PSY542	Industrial Standards & Protocol		2-0-4		
PSY544	Real time simulation		0-0-8		
PSY546	Professional software		2-0-4		
	NHEQF Level				6.5

SEMESTER III

Code	Type	Cr	L-T-P	Total Credits	Level
PSY601	High Voltage Engineering	4	3-0-2	16	600-699*
	Open Elective *****				
OEE601	Electric Vehicle Technology	4	3-1-0		
PSY603	Minor Project/Research Thesis/Patent	8	-		

SEMESTER IV

	Type	Cr	L-T-P	Total Credits	
PSY602	Major Project/Research Thesis/Patent	16	-	16	-
	NHEQF Level				7.0

*Level

Refer draft UGC Curriculum and credit framework for PG Programme

**Self Study

Self Study can be offered as Seminar or MOOC from online platform. In case of seminar, the respective required to collect seminar topic from the students in the beginning of first semester. The list of seminar topics must be approved by the department BOS within 15 days of the beginning of semester and submitted to Dean (Academics -PG).

***** Skill Enhancement Course 1**

Department must provide rich basket of Skill Enhancement Courses so that it can be changed in subsequent years.

******Audit Course**

As per AICTE Model Curriculum the audit courses are listed below. If department wants to offer any other audit course, then the respective department requires to get approval of the additional audit course from the Department BOS and submit BOS approved syllabus and scheme to Dean PG. Further, Dean PG will get it approved from the Academic Council in order to ensure smooth conduct of lecture and practical.

Open Elective (OEC): Each department is required to offer one open elective course of interdisciplinary nature. The open elective course offered by the respective department acts as an open elective for the students of other departments.

DELHI TECHNOLOGICAL UNIVERSITY
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Scheme for Part Time M. Tech.PSY as per NEP-2020

SEMESTER I					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
PSY501	Advanced Power System Analysis	4	3-0-2	12	500-599*
PSY503	Power System Dynamics & Stability	4	3-0-2		
PSY505	Power Electronics for Renewable Energy	4	3-1-0		
SEMESTER II					
	Type	**Cr**	**L-T-P**	**Total Credits**	**Level**
PSY502	Advanced Power System Protection	4	3-0-2	12	500-599*
PSY504	Power System operation & Control	4	3-0-2		
	Departmental Elective 2	4			
PSY520	PMU&Wide area Monitoring System		3-1-0		
PSY522	HVDC Transmission		3-1-0		
PSY524	EHVAC Transmission		3-1-0		
PSY526	Power System Transients		3-1-0		
PSY528	Grid Integration of Renewable Energy System		3-1-0		
	NHEQF Level				6.5
SEMESTER III					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
PSY507	Flexible AC Transmission System	4	3-1-0	12	500-599*
	Departmental Elective 1	4			
PSY511	Advanced Control System		3-1-0		
PSY513	Power System Reliability		3-1-0		
PSY515	Smart Grid & Microgrid		3-1-0		
PSY517	Soft computing Techniques		3-1-0		
PSY519	Power Quality		3-1-0		
	Self-Study	2	-		
PSY551	Seminar				
PSY553	MOOC				
	Skill Enhancement Course 1***	2			
PSY541	PCB design		0-0-4		
PSY543	Professional software		1-0-2		
	Audit Course				
UEC501	English for Research Paper Writing	0	2-0-0		
UEC503	Disaster Management		2-0-0		
UEC505	Sanskrit for Technical Knowledge		2-0-0		

UEC507	Value Education		2-0-0		
UEC509	Constitution of India		2-0-0		
UEC511	Pedagogy Studies		2-0-0		
UEC513	Stress Management by Yoga		1-0-2		
UEC515	Personality Development through Life Enlightening Skills		2-0-0		
SEMESTER IV					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
	Departmental Elective 3			12	500-599*
PSY530	Optimization Techniques	4	3-1-0		
PSY532	Forecasting Techniques		3-1-0		
PSY534	Electricity Market Regulations & Trading		3-1-0		
PSY536	Power System Planning		3-1-0		
PSY538	Substation Automation		3-1-0		
UCC502	Research Methodology and IPR	4	3-1-0		
	Skill Enhancement Course 2 /Industrial Training	4			
PSY540	Industrial Training		0-0-8		
PSY542	Industrial Standards & Protocol		2-0-4		
PSY544	Real time simulation		0-0-8		
PSY546	Professional software		2-0-4		
	NHEQF Level				6.5
SEMESTER V					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
PSY601	High Voltage Engineering	4	3-0-2	16	600-699*
	Open Elective ***				
OEE601	Electric Vehicle Technology	4	3-1-0		
PSY603	Minor Project/Research Thesis/Patent	8	-		
SEMESTER VI					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
PSY602	Major Project/Research Thesis/Patent	16	-	16	-
	NHEQF Level				7.0

ANNEXURE – II

Scheme of Evaluation for the course of all Programme

S. No.	Course Credits	Course Type			Examination		Relative Weightage				
		L	T	P/ST	TH	PR/ST	CWS	PRS/STS/CMS	MTE	ETE/EME	PRE/STE
1.	2	1	1	0	Yes	No	25	-	25	50	-
2.	2	2	0	0							
3.	4	3	1	0							
4.	2	1	0	2	Yes	No	15	25	20	40	-
5.	4	3	0	2							
6.	4	2	1	2							
7.	4	2	0	4							
8.	4	1	0	6							
9.	4	0	1	6							
10.	2	0	0	4	No	Yes	-	50	-	-	50
11.	4	0	0	8							
12.	2/4	Self Study (Seminar)/ Industrial Training			No	Yes	-	40	-	-	60
13.	8	Minor Project/ Research Thesis/ Patent									
14	16	Major Project/ Research Thesis/ Patent/			NO	YES	-	-	-	-	100

ANNEXURE – III

Teaching Scheme					Contact Hours/ Week			Exam Duration (h)		Relative Weights (%)				
S. No	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
SEMESTER I														
1.	PSY501	Advanced Power System Analysis	CORE	4	3	0	2	3	2	15	25	20	40	-
2.	PSY503	Power System Dynamics & Stability	CORE	4	3	0	2	3	2	15	25	20	40	-
3.	PSY505	Power Electronics for Renewable Energy	CORE	4	3	1	0	3	0	25	-	25	50	-
4.	PSY507	Flexible AC Transmission System	CORE	4	3	1	0	3	0	25	-	25	50	-
5.	PSY511	Advanced Control System	DEC1	4	3	1	0	3	0	25	-	25	50	-
	PSY513	Power System Reliability	DEC1	4	3	1	0	3	0	25	-	25	50	-
	PSY515	Smart Grid &Microgrid	DEC1	4	3	1	0	3	0	25	-	25	50	-
	PSY517	Soft computing Technique	DEC1	4	3	1	0	3	0	25	-	25	50	-

	PSY519	Power Quality	DEC1	4	3	1	0	3	0	25	-	25	50	-
6.	PSY551	Seminar	SS	2	-	-	-	0	2	-	40	-	-	60
	PSY553	MOOC	SS	2	-	-	-	-	-	-	-	-	-	-
7.	PSY541	PCB Design	SEC	2	0	0	4	0	2	-	50	-	-	50
	PSY543	Professional Software	SEC	2	1	0	2	3	2	15	25	20	40	-
8.	UEC501	English for Research Paper Writing	UEC	0	2	0	0	-	-	25	-	25	50	-
	UEC503	Disaster Management	UEC	0	2	0	0	-	-	25	-	25	50	-
	UEC505	Sanskrit for Technical Knowledge	UEC	0	2	0	0	-	-	25	-	25	50	-
	UEC507	Value Education	UEC	0	2	0	0	-	-	25	-	25	50	-
	UEC509	Constitution of India	UEC	0	2	0	0	-	-	25	-	25	50	-
	UEC511	Pedagogy Studies	UEC	0	2	0	0	-	-	25	-	25	50	-
	UEC513	Stress Management by Yoga	UEC	0	1	0	2	-	-	15	25	20	40	-
	UEC515	Personality Development through Life Enlightening Skills	UEC	0	2	0	0	-	-	25	-	25	50	-
Total Credits				**24**										

Teaching Scheme					Contact Hours/ Week			Exam Duration (h)		Relative Weights (%)				
S.N	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
SEMESTER II														
1.	PSY502	Advanced Power System Protection	CORE	4	3	0	2	3	2	15	25	20	40	-
2.	PSY504	Power System operation & Control	CORE	4	3	0	2	3	2	15	25	20	40	-
3.	PSY520	PMU&Wide area Monitoring System	DEC2	4	3	1	0	3	0	25	-	25	50	-
	PSY522	HVDC Transmission	DEC2	4	3	1	0	3	0	25	-	25	50	-
	PSY524	EHVAC Transmission	DEC2	4	3	1	0	3	0	25	-	25	50	-
	PSY526	Power System Transients	DEC2	4	3	1	0	3	0	25	-	25	50	-
	PSY528	Grid Integration of Renewable Energy System	DEC2	4	3	1	0	3	0	25	-	25	50	-

4	PSY530	Optimization Techniques	DEC3	4	3	1	0	3	0	25	-	25	50	-
	PSY532	Forecasting Techniques	DEC3	4	3	1	0	3	0	25	-	25	50	-
	PSY534	Electricity Market Regulations & Trading	DEC3	4	3	1	0	3	0	25	-	25	50	-
	PSY536	Power System Planning	DEC3	4	3	1	0	3	0	25	-	25	50	-
	PSY538	Substation Automation	DEC3	4	3	1	0	3	0	25	-	25	50	-
5.	UCC502	Research Methodology & IPR	UEC	4	3	1	0	3	0	25	-	25	50	-
6.	PSY540	Industrial Training	SEC	4	0	0	8	0	2	-	50	-	-	50
	PSY542	Industrial Standards & Protocol	SEC	4	2	0	4	3	2	15	25	20	40	-
	PSY544	Real time simulation	SEC	4	0	0	8	0	2	-	50	-	-	50
	PSY546	Professional software	SEC	4	2	0	4	3	2	15	25	20	40	-
Total Credits				**24**										

Teaching Scheme					Contact Hours/ Week			Exam Duration (h)		Relative Weights (%)				
S. No	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
SEMESTER III														
1.	PSY601	High Voltage Engineering	CORE	4	3	0	2	3	2	15	25	20	40	-
2.	OEE601	Electric Vehicle Technology	OEE	4	3	1	0	3	0	25	-	25	50	-
3.	PSY603	Minor Project/Research Thesis/Patent	CORE	8	0	0	8	0	2	-	40	-	-	60
Total Credits				**16**										

Teaching Scheme					Contact Hours/ Week			Exam Duration (h)		Relative Weights (%)				
S. No	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
SEMESTER IV														
1.	PSY602	Major Project/Research Thesis/Patent	CORE	16	-	-	-	-	-	-	-	-	-	100
Total Credits				**16**										

ANNEXURE – V

Important Note for AY 2024-2025:

Further, all the departments must provide the list of courses, existing subject codes, and new subject codes (as per updated format Annexure – III and Annexure –IV) that were offered in the AY 2024-2025 (for both 1st Year and 2nd Year). In order to maintain consistency with the course code in the result section, it is decided that a new course code must be provided by the department for the courses already offered in the August 2024 and January 2025 sessions. The required format is given below:

Semester I				
S. No	**Existing Subject Code**	**Existing Subject Name**	**New Course Code**	**New Subject Name (Subject Name will remain same as of earlier)**
1	PSY501	Advanced Power System Analysis	PSY501	Advanced Power System Analysis
2	PSY505	Power System Dynamics & Stability	PSY503	Power System Dynamics & Stability
3	PSY507	Power Electronics for Renewable Energy	PSY505	Power Electronics for Renewable Energy
4	PSY509	Flexible AC Transmission System	PSY507	Flexible AC Transmission System
5	PSY5315	Soft computing	PSY517	Soft computing Techniques
6	PSY525	Self-Study	PSY551	Seminar
			PSY553	MOOC
7	PSY523	Skill Enhancement Course 1	PSY541	PCB design
8	UEC501	Audit Course	UEC513	Stress Management by Yoga
Semester II				
S. No	**Existing Subject Code**	**Existing Subject Name**	**New Course Code**	**New Subject Name (Subject Name will remain same as of earlier)**
1	PSY502	Advanced Power System Protection	PSY502	Advanced Power System Protection
2	PSY504	Power System operation & Control	PSY504	Power System operation & Control
3	PSY5322	HVDC Transmission	PSY522	HVDC Transmission
4	PSY5341	Optimization Techniques	PSY530	Optimization Techniques
5	UCC502	Research Methodology and IPR	UCC502	Research Methodology and IPR
6	PSY546	Skill Enhancement Course 2	PSY546	Professional software

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY501	Advanced Power System Analysis	3	0	2	Basic understanding of power system

Course Objective
To equip students with the knowledge and skills to analyze the behavior of electrical power systems, including calculating power flows, voltage levels, and stability under different operating conditions, allowing them to design, operate, and troubleshoot complex power grids effectively.

Course Outcome(CO):
CO1.Develop model of a given power system.
CO2.Evaluate the power system network using simple bus building algorithms.
CO3.Perform power flow analysis using numerical techniques.
CO4.Calculate the economic load and optimal power flow .
CO5.Examine the behavior of the power system under faulted condition in a power system.
CO6.Realize the stability status of the power system under transient conditions.

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	2	2	3
CO5	3	2	3
CO6	3	2	1

Course Contents

Unit	Content	Contact Hours
1	Introduction and design considerations of EHV AC systems. Analysis of long transmission lines. Modelling of power system components. Formation of power network matrices. Zbus building.	10

2	Power Flow studies. Gauss, N-R method decoupled and fast decoupled methods. Programming considerations for large systems – sparse matrix techniques.	**10**
3	Economic Load Dispatch, Optimal Power Flow, Fault Studies - Symmetrical and unsymmetrical faults using matrix methods.	**12**
4	Stability Studies – Transient and dynamic stability analysis of single machine connected to infinite bus and multi-machine systems	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1	Duncan Duncan Glover and Mulukutla S. Sarma. Power System Analysis and Design 7th Edition, Cengage India.	2024
2	John Grainger and William Stevenson, Jr. Power System Analysis, McGraw-Hill Education,	2017
3	Anderson P.M., Analysis of Faulted Power Systems, IEEE Press	2024
4	Hadi Saadat, 'Power System Analysis', 3 rd Edition (revised), Tata McGraw Hill Publishing Company	2011
5	I.J. Nagrath and D.P. Kothari, 'Modern Power System Analysis', 4th Edition, Tata McGraw-Hill Publishing Company	2011

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY503	Power System Dynamics & Stability	**3**	**0**	**2**	Basic understanding of power system

Course Objective
To equip students with the knowledge and skills to analyze the dynamic behavior of electrical power systems, understand various stability issues that can arise, and design control strategies to maintain system stability under different operating conditions, ensuring reliable power delivery to consumers.

Course Outcome(CO):
CO1: Develop mathematical models of power systems for dynamic studies.
CO2: Evaluate the transient stability limits of power system
CO3: Analyze small signal stability problems and understand methods of improving stability.
CO4: Understand frame of references and model components of power systems
CO5: Identify the methods to improve dynamic & transient stability of power systems

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**3**	**2**	**1**
CO2	**3**	**2**	**1**
CO3	**3**	**2**	**1**
CO4	**2**	**2**	**3**
CO5	**3**	**2**	**3**

Course Contents

Unit	Content	Contact Hours
1	Basis concepts of dynamical systems, Stability Definitions, Basic dynamic equations of a synchronous machine: Swing equation	**10**

2	Solution of swing equation by equal area criterion, Euler method, modified Euler's method and R-K methods. Analysis of single machine Small signal stability, eigenvalue analysis. Power System Stabilizers	**12**
3	dqo transformation, Stator and Rotor voltage and flux linkage equations, per unit representation, excitation systems, prime mover controller and associated systems	**10**
4	Dynamic stability of SMIB system with the aid of Phillips-Heffron model, design of PSS for SMIB system	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1	Prabha Kundur, "Power system stability and control", Tata McGraw Hill	1994
2	K. R. Padiyar, Power system dynamics, stability and control, BS Pub.	2004
3	P. W. Sauer & M A Pai: Power system dynamics and stability: Pearson.	1998.
4	Kimbark EW. "Power system stability-III, synchronous machines", John Wiley & Sons	2007
5	P.M. Anderson and A. A. Fouad, "Power system control and stability", IEEE Press	1981
6	R. Ramanujam, "Power Systems Dynamics"- PHI Publications	2009

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY-505	Power Electronics for Renewable energy	3	1	0	Basic understanding of power system

Course Objective
To equip students with a comprehensive understanding of how power electronic converters are used to integrate variable renewable energy sources like solar and wind power into the electricity grid.

Course Outcome(CO):
CO1:Basics of power electronics for renewable integration and HVDC
CO2:Study of grid synchronization techniques
CO3:Modeling, design and control of solar PV characteristics
CO4:Basic configuration and control of wind energy conversion

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	3	1
CO2	1	2	3
CO3	3	2	1
CO4	2	2	3

Course Contents

Unit	Content	Contact Hours
1	Basics of Power Converters: AC to DC converters (1 phase, 3 phase), DC to AC converters(1 phase, 3 phase), Multilevel DC to AC converters , Types of DC-DC converters-non-isolated and isolated, Basic control principles in power electronics, DC-DC converter design and modelling of buck, boost and buck boost DC-DC converter.	8

2	Introduction to HVDC, Need and Comparison with EHVAC Transmission. Application of power converters to HVDC lines, Introduction to BESS.	**4**
3	Grid synchronization: Need and different conventional techniques SRF-PLL and DSOGI-PLL.	**8**
4	Solar PV Systems: Solar PV characteristics, Grid requirement for PV, Power electronic converters used for solar PV, Control techniques, MPPT, Grid connected and Islanding mode	**12**
5.	Wind Energy Conversion: Wind Turbine characteristics, Grid requirement for Wind, DFIG for wind generators and Control	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Frede Blaabjerg, Control of Power Electronic Converters and Systems, Academic Press, 2018	2018
2.	Remus Teodorescu, Marco Liserre, Pedro Rodriguez, "Grid Converters for Photovoltaic and Wind Power Systems" Wiley-IEEE Press, January 2011.	2011
3.	Suleiman M. Sharkh, Mohammad A. Abu-Sara, Georgios I. Orfanoudakis, Babar Hussain, "Power Electronic Converters for Microgrids" Wiley-IEEE Press, April 2014.	2014
4.	Fang Lin Luo, Hong Ye, "Advanced DC/AC Inverters: Applications in Renewable Energy" CRC Press.	2013

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY-507	Flexible AC TransmissionSystem	3	1	0	Basic understanding of power system

Course Objective
To provide students with a comprehensive understanding of power electronic devices used to control reactive power flow in AC transmission lines, enabling them to improve power system stability, voltage regulation, and transmission capacity by utilizing various FACTS controllers like Static Var Compensators (SVCs)

Course Outcome(CO):
CO1:Apply FACTS controllers for system control and protection.
CO2:Describe and analyze various reactive power compensation techniques.
CO3:Conduct dynamic studies of power systems with FACTS controllers.
CO4:Analyze the operation and characteristics of key FACTS devices.

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	3	1
CO2	1	2	3
CO3	3	2	1
CO4	2	2	3

Course Contents

Unit	Content	Contact Hours
1	Introduction, principles of reactive power control and transmission line compensation, series and shunt reactive power compensation,	6

2	Concept of Flexible AC Transmission systems (FACTS), Static Var Compensator (SVC), thyristor controlled reactor, thyristor switched capacitor, thyristor controlled series capacitor, static synchronous compensator, static synchronous series compensator, thyristor controlled phase angle regulator and unified power flow controller.	**14**
3	Modeling and analysis of SVC, STATCOM, TCSC, SSSC, UPFC and IPFC, use of FACTS controllers in system control and protection.	**14**
4.	Harmonic and filters, simulation and study of FACTS Controllers under dynamic conditions.	**8**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	Miller, T.J.E., "Reactive Power Control in Electric Systems", John Wiley	1983
2.	Hingorani, N.G., and Gyugyi, L., "Understanding FACTS", IEEE Press.	2000
3.	E. Acha, V.G. Agelidis, "Power Electronic control in Electrical Systems", Newnes, Butterworth, Elsevier.	2002
4.	R.M. MATHUR, R.K. VARMA, " Thyristor based FACTS controller for Eletctrical Transmission systems, John Wiley.	2002

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY541	PCB Design	**0**	**0**	**4**	Basic understanding of power system

Course Contents

S.no	Content	Contact Hours
1	PCB design**:** Same as the syllabus of PES/C&I	**40**

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY543	Professional Software	1	0	2	Basic understanding of power system

Course Objective
To equip learners with the necessary practical abilities and knowledge in a specific area, enabling them to perform tasks effectively, enhance their job performance, and improve their employability prospects, often focusing on industry-relevant skills and practical applications.

Course Outcome(CO):
CO1:Skill development in related technology of main course
CO2: Exposure to professional tools
CO3: Ability to design new concepts on professional tools
CO4: Draft reports on professional tools

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	3	1
CO2	1	2	3
CO3	3	2	1
CO4	2	2	3

Course Contents

S.no	Content	Contact Hours
1	Professional software (ETAP/Digsilent/PSCAD): Introduction to computer modelling requirement of power system analysis. Time step requirement for various analysis in power system. Distinction between EMT and RMS simulation, their advantages and disadvantages. Distinction between different types of Power system software commercially available. Modelling of various components in Power system software. Building of standard IEEE benchmark	30

	models: single machine infinite bus, kundur two area system, nine bus system etc. Transient and dynamic analysis on the benchmark models.	

Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	ETAP User Manual	2024
2.	DISILENT User Manual	2024
3.	PSCAD User Manual	2024

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY-502	Advanced Power System Protection	**3**	**0**	**2**	PSY-501

Course Objective
To provide in-depth knowledge about the principles, design, and application of advanced protection schemes for various power system components like transmission lines, transformers, generators, and buses, focusing on complex fault detection, selective tripping mechanisms, and the use of digital relays to ensure reliable and fast fault isolation while minimizing disruption to the overall power system operation.

Course Outcome(CO):
CO1:Understand philosophy of various relays used in power system protection
CO2:Acquire knowledge in various type of relaying schemes
CO3:Understand setting of protection relays
CO4:Knowledge of switchgear equipments operation

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**3**	**3**	**3**
CO2	**2**	**2**	**2**
CO3	**3**	**2**	**2**
CO4	**2**	**3**	**2**

Course Contents

Unit	Content	Contact Hours
1	Review of Electromagnetic Relays, relay terminology, relay characteristics, basic protection schemes, overcurrent and directional overcurrent relays, differential relays, relay coordination. distance relays,. Basic construction of static relays, input output devices, Static comparators. Different types of	**10**

	relays: static, digital and computer aided relaying.CTs, PTs, effect of CT saturation on relay operation.	
2	Protection of Alternators: Protection against Stator fault (Phase to Phase and Phase to Ground), Balanced earth fault protection, Stator inter turn protection, Unbalanced loading of Alternator, Prime Mover failure, Overvoltage protection, Overloading (or over current) Protection, Restricted Earth fault and standby earth fault protection, Rotor Fault Protection.	**10**
3	Protection of Transformer: Overcurrent and unrestricted Earth fault protection, Different CT connections, Balanced (Restricted) earth fault protection, Harmonic restraint, Frame leakage protection.	**6**
4	Feeder protection: Time Graded protection, Differential Protection Transmission Line Protection: Introduction to distance relay, Simple Impedance relay, Reactance relay, Mho relays, comparison of distance relay – Choice between Impedance, Reactance and Mho relay, High speed Impedance relay, setting of distance relays.	**8**
5	Review of arc formation, properties and characteristics; interruption of current in circuit breakers; high resistance and low resistance theories of interruption; Effect on circuit breaker performance under different conditions in power system operation; Circuit breaker ratings. Study and operation of air blast, SF6, vacuum and D.C. circuit breakers. Selection and design considerations of CB.	**8**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	Paul M. Anderson, Power System Protection, Wiley-IEEE Press	1999
2.	Protective Relays Application and Guide, GEC Measurements limited	1990
3.	Badri Ram & DN Viswakarma – Power System Protection & Switch Gear – McGraw Hill	2023
4.	YG Paithankar and SR Bhide Fundamentals of power system protection – PHI	2003

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY504	Power System operation & Control	**3**	**0**	**2**	PSY-501

Course Objective
To equip students with the knowledge and skills to analyze, design, and implement control strategies to maintain a stable and reliable power system by managing power generation, transmission, and distribution, ensuring a continuous supply of electricity with acceptable quality while optimizing economic operation across varying load conditions.

Course Outcome(CO):
CO1:Understand philosophy of economic load dispatch, load frequency control and its modeling
CO2:Acquire knowledge in generation dispatching schemes
CO3:Acquire knowledge in reactive and voltage control using compensation devices
CO4:Understand the supervisory control structure of power system

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**2**	**3**	**2**
CO2	**3**	**2**	**3**
CO3	**2**	**2**	**3**
CO4	**3**	**3**	**2**

Course Contents

Unit	Content	Contact Hours
1	General characteristics of modern power systems, evolution, structure, power system control, operating states of a power system and control strategies, economic load dispatch, price based unit commitment problem.	**10**

2	Concept of reactive power, reactive power flow analysis, active power and frequency control, real power balance and its effect on system frequency;	**10**
3	Automatic generation control 416 (AGC), generation control loops, load frequency control, AGC with economic dispatch performance measures, large signal, small signal, control and protective functions, ac and dc regulators, design of robust controllers in power systems.	**8**
4	Division of power system into control areas, load-frequency control of single area and two area system - optimum control criterion, two area and multi-areas power system with and without integral control	**6**
5	SCADA systems and its applications in power networks, supervisory control, supervisory master stations, remote terminal units, communication links.	**8**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	P Kundur, Power system Stability and Control, McGraw-Hill, Inc	1994
2.	Elgerd O.I, "Electric Energy System Theory – an Introduction", Tata McGraw Hill, New Delhi	2013
3.	PSR Murthy, Operation and Control of Electric Power systems, BS publications, Hyderabad	2005
4.	Hadi Saadat, Power System Analysis , Tata McGraw-Hill, Edition	2002

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY542	Industrial Standards & Protocol	2	0	4	Basic understanding of power system

Course Objective
To equip learners with the necessary practical abilities and knowledge in a specific area, enabling them to perform tasks effectively, enhance their job performance, and improve their employability prospects, often focusing on industry-relevant skills and practical applications.

Course Outcome(CO):
CO1:Skill development in related technology of main course
CO2: Exposure to professional tools
CO3: Ability to design new concepts on professional tools
CO4: Draft reports on professional tools

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	3	1
CO2	1	2	3
CO3	3	2	1
CO4	2	2	3

Course Contents

Unit	Content	Contact Hours
1	Industrial Standards & Protocol**:**IEC 61860 Protection Standard/Protocol Introduction to automation and protection. IED communication protocols: IEC 61850. Goose messaging and sample value protocols. Building a substation automation project from scratch. Testing of IEC protocols with relevant softwares.	50

Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	IEC 61860 Standard	2024

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY544	Real time simulation	0	0	8	Basic understanding of power system

Course Objective
To equip learners with the necessary practical abilities and knowledge in a specific area, enabling them to perform tasks effectively, enhance their job performance, and improve their employability prospects, often focusing on industry-relevant skills and practical applications.

Course Outcome(CO):
CO1:Skill development in related technology of main course
CO2: Exposure to professional tools
CO3: Ability to design new concepts on professional tools
CO4: Draft reports on professional tools

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	3	1
CO2	1	2	3
CO3	3	2	1
CO4	2	2	3

Course Contents

Unit	Content	Contact Hours
1	Real time simulation(Hardware in loop): Introduction to computer modelling requirement of power system analysis in real time. Time step requirement for various analysis in power system and time synchronization with GPS clocks and its protocol. Distinction between EMT and RMS simulation, their application in real time system. Distinction between different types of real time Power system software commercially available. Modelling of various	70

	components in Power system real time software. Building of standard IEEE benchmark models: single machine infinite bus, kundur two area system, nine bus system etc. Transient and dynamic analysis on the benchmark models in real time systems.	

Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	OPALRT User Manual	2024

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY546	Professional software	2	0	4	Basic understanding of power system

Course Objective
To equip learners with the necessary practical abilities and knowledge in a specific area, enabling them to perform tasks effectively, enhance their job performance, and improve their employability prospects, often focusing on industry-relevant skills and practical applications.

Course Outcome(CO):
CO1:Skill development in related technology of main course
CO2: Exposure to professional tools
CO3: Ability to design new concepts on professional tools
CO4: Draft reports on professional tools

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	3	1
CO2	1	2	3
CO3	3	2	1
CO4	2	2	3

Course Contents

Unit	Content	Contact Hours
1	Professional software:(LABVIEW) Same as the syllabus of PES/C&I **OR** Professional software: (PSS/E): Introduction to computer modelling requirement of power system analysis. Time step requirement for various analysis in power system. Distinction between EMT and RMS simulation, their advantages and disadvantages. Distinction between different types of Power system software commercially available. Modelling of various components in Power system software. Building of standard IEEE benchmark models: single machine infinite bus, kundur two area system, nine bus system etc. Transient and dynamic analysis on the benchmark models.	50

Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1	PSS/E User Manual	2024

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY601	High Voltage Engineering	**3**	**0**	**2**	Basic understanding of power system

Course Objective
To provide students with a comprehensive understanding of high voltage systems and the equipment used in them. Students learn how to design, construct, and maintain high voltage equipment. They also learn how to test and measure high voltages, and how to analyze the stress on high voltage equipment.

Course Outcome(CO):
CO1:To impart knowledge on generation of high AC and DC voltages
CO2:To provide adequate knowledge to simulate and generate impulse voltages
CO3:To expose the different techniques of measuring High voltages
CO4:To provide knowledge on different types of electrical stresses on power system equipment

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**3**	**2**	**3**
CO2	**3**	**3**	**2**
CO3	**3**	**2**	**2**
CO4	**3**	**3**	**3**

Course Contents

Unit	Content	Contact Hours
1	Characteristics of impulse and switching surge voltage, analysis of single stage impulse generator circuit, multi-stage impulse generators, constructional features of multi-stage impulse generators. Generation of Switching surges.	**10**
2	Generation of high direct voltages: Rectifier circuits, voltage doubler and multiplier circuits, cascade circuits; Cascaded transformers, series resonant	**10**

	circuits; Measurement of high voltages.	
3	Breakdown in Gases: Breakdown in Uniform field, Townsend's mechanisms, Streamer Theory, Paschen's Law, breakdown in electronegative gases. Breakdown of gases in non-uniform field: effect of space charge, corona for positive and negative polarities. Breakdown phenomena under AC voltage and impulse voltage.	**10**
4	Breakdown in Liquids: Classification of liquids, breakdown in pure liquids, breakdown in commercial liquids. Breakdown in Solids: Intrinsic breakdown, electromechanical breakdown, Thermal breakdown, Treeing and tracking, breakdown in Composite Insulators.	**8**
5	High Voltage Testing of Power System Equipment and Insulation Coordination.	**4**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	Naidu, M.S. and Kamaraju, V. , "High Voltage Engineering", TMH	2017
2.	Wadhwa, C.L., "High Voltage Engineering", Wiley Eastern	2012
3.	Kuffel & Zaengl, "High Voltage Engineering", Pergamon Press	2000
4.	Subir Ray, An introduction to High Voltage Engineering, PHI	2013

Departmental Electives I

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY511	Advanced Control Systems	**3**	**1**	**0**	Basic understanding of control system

Course Objective
To provide students with in-depth knowledge and skills to model, analyze, and design complex control systems using advanced techniques, including state-space representation, optimal control, adaptive control, and predictive control, allowing them to tackle intricate systems with multiple inputs and outputs, non-linear dynamics,

Course Outcome(CO):
CO1 Acquire knowledge and mathematical tools for modern control systems modelling.
CO2.Explain a modern control system's stability, controllability, and observability
CO3 Acquire knowledge of state space and state feedback in modern control systems.
CO4 Perform stability analysis of nonlinear systems by Lyapunov method.
CO5.Incorporate and compensate for real-world practical aspects in operation of modern control
CO6.Apply industry-compatible design tools and techniques for study of modern control systems.

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**3**	**1**	**3**
CO2	**2**	**2**	**2**
CO3	**3**	**2**	**3**
CO4	**2**	**2**	**2**
CO5	**3**	**1**	**1**
CO6	**2**	**2**	**2**

Course Contents

Unit	Content	Contact Hours

1	Modeling of dynamical systems in continuous time state space and discrete time state space model, Solution of continuous time state equation, Solution of discrete time state equation.	**10**
2	General concept of Controllability and Observability, Controllability test for continuous time and discrete time system, Observability test for continuous time and discrete time system, Stabilizabilty and Detectability definition and tests, loss of Controllability and Observability due to sampling, Controllable and Observable canonical forms.	**10**
3	Nonlinear Models, Equilibrium points, Linearization of Nonlinear models, Separable Nonlinearities, Describing function analysis, Phase plane analysis of nonlinear systems, Bang-Bang control system, feedback linearization. Stability concept, stability definition in the sense of Lyapunov, Lyapunov stability theorem, Lyapunov instability theorem, direct method of Lyapunov for continuous time and discrete time systems,	**12**
4	Lyapunov function for nonlinear systems. Pole placement technique, Ackerman's approach and Linear quadratic regulator for continuous time and discrete time systems, sliding mode control, H-infinity control, full order and reduced order observer design.	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1	B. N. Sarkar, Advanced Control Systems PHI Learning Private Limited	2013
2	Somanath Majhi, Advanced Control Theory, Cengage Learning	2009
3	I J Nagarath, M. Gopal, Control System Engineering, New Age International	2017
4	Automatic Control Systems – B C Kuo – PHI – 7th edition	2003
5	Modern Control Engineering - K. Ogata – PHI – 3rd edition	2015

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY513	Power System Reliability	**3**	**1**	**0**	Basic understanding of power system

Course Objective
To equip students with the knowledge and skills to analyze, evaluate, and improve the reliability of electrical power systems by understanding key reliability indices, modeling techniques, fault analysis, and mitigation strategies to ensure uninterrupted electricity supply to consumers, while considering factors like system design, maintenance practices, and risk assessment.

Course Outcome(CO):
CO1 Understanding of the main principles in power system reliability analysis.
CO2 Knowledge of different methods and tools for reliability analysis
CO3 Model electric power systems with respect to reliability of supply..
CO4 Analyze electric power systems with respect to reliability of supply..

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**1**	**1**	**1**
CO2	**2**	**2**	**2**
CO3	**3**	**2**	**2**
CO4	**2**	**3**	**2**

Course Contents

Unit	Content	Contact Hours
1	Basic probability theory, review of concepts, probability distributions. Markov processes, State Transition Matrix and State Transition Diagram.	**10**

	Definition of Reliability, general reliability function, evaluation of reliability using state enumeration.	
2	Tie set and cut set method. Reliability indices from state transition matrix and state transition diagrams. Models for generation system reliability evaluation, loss of load indices, loss of energy indices, frequency and duration methods. Reliability evaluation of two area interconnected systems.	**12**
3	Conditional probability approach for reliability evaluation of a generation-transmission system. Transmission system reliability evaluation using average interruption rate method and frequency and duration methods.	**10**
4	Evaluation of interruption indices for radial distribution systems. Introduction to protective system reliability evaluation.	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1	Billington, Ringley & Wood, Power System Reliability Calculation, MIT Press	1972
2	Endeerny, J, Reliability Modelling in Power System, John Wiley, NY	2009
3	Roy Billintonm, Ronald N. Allan, Reliability Evaluation of Power Systems	2008
4	R. K. Saket P. Sanjeevikumar, Reliability Analysis of Modern Power Systems, IEEE Press, WIELY	2024

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY515	Smart Grid & Microgrid	**3**	**1**	**0**	Basic understanding of power system

Course Objective

Provide students with a comprehensive understanding of the technologies, components, operation, and control strategies within both smart grids (large-scale, interconnected power systems) and microgrids (localized, smaller grids), including the integration of renewable energy sources, energy storage, advanced communication networks, and intelligent control systems, enabling them to analyze, design, and manage efficient and resilient power systems.

Course Outcome(CO):

CO1 Learning about the main operating modes of a microgrid
CO2 Benefits of microgrid operation with distributed generation
CO3 Operation challenges in microgrids and adoption of smart grid features.
CO4 Use of power electronic devices for smart grid operation.

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**2**	**2**	**3**
CO2	**3**	**1**	**2**
CO3	**3**	**1**	**2**
CO4	**2**	**2**	**3**

Course Contents

Unit	Content	Contact Hours
1	Introduction: Structure and Fundamental Problems of Electrical Power Systems, Principles of Electrical Power Control, Power Flow Control, Distributed Generation and Energy Storage	**10**

2	Benefits to Grids, Damping of System Oscillations, Power Quality Control, Fully Integrated Power System-Smart Grid, Smart Electrical Energy Networks Concept-Microgrids & Picogrids. Microgrid configuration and interconnection, Technical advantages and challenges of Microgrid.	**10**
3	Distribution system and operational issues of Microgrid, power quality, Ride through, Grid synchronization. Network management needs of Microgrid, Microsource generation control, Domestic process control, Energy storage, Regulation and load shifting, Microsource controller, Decentralized Operation, Protection co-ordination, Grid Synchronization.	**10**
4	PWM Rectifiers, Multilevel Converters, Neutral point Clamped VSC, space vector PWM, Z-source converters, Three level and Four wire inverters with z source, Grid-imposed Frequency VSC system control , D-STATCOM, SSSC, UPFC, Back to Back HVDC Conversion Systems, Bricks-Buses-Software (BBS). SCADA and control of DNO SCADA systems (Centralised & Distributed).	**12**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1	Mini S. Thomas, John Douglas McDonald, "Power System SCADA and Smart Grids", CRC Press	2015
2	Chowdhary, S. P. Chowdhury and P. Crossley, "Microgrids and Active Distribution Network", IET	2009
3	R. Strzelecki, G. Benesek, "Power Electronics in Smart Electrical Energy Networks", Springer	2008
4	Amirnaser Yazdani & Reza Iravani, "Voltage Sourced Converters in Power Systems: Modeling, Control, and Applications", IEEE Press	2010
5	Nick Jenkins et al., "Embedded Generation", IET	2000

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY517	Soft computing Techniques	**3**	**1**	**0**	Basic understanding of power system

Same as CSI517

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY-519	Power Quality	**3**	**0**	**2**	PSY-501

Course Objective
To provide students with a comprehensive understanding of the concepts related to maintaining a steady and stable electrical power supply, including identifying and analyzing various power quality issues like voltage fluctuations, harmonics, and power factor variations, along with the methods to measure and mitigate these problems.

Course Outcome(CO)

CO1: Understand basics of power quality issues
CO2: Knowledge of power quality standards and analysis techniques
CO3: Model, design and control of DSTATCOM
CO4: Exposure to working and control of DVR and UPQC

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**3**	**1**	**2**
CO2	**2**	**2**	**3**
CO3	**3**	**1**	**2**
CO4	**2**	**2**	**3**

Course Contents

Unit	Content	Contact Hours
1	Classification of Power Quality issues, characterization, Power quality problems: Poor load power factor, Non-linear and unbalanced loads, DC offset, Notching, Disturbance, flicker, transients, voltage	**10**

	fluctuations, sags/swells/unbalance, Power Quality Indices, recommended practices, Influence of Non-Sinusoidal Conditions	
2	Overview of power quality standards: IEEE and IEC Power quality Monitoring: Objectives and measurement issues, different monitoring instruments – Power quality analyzer, harmonic spectrum analyzer, flicker meters Analysis in the periodic steady state, Time domain method, Frequency domain methods, IRPT, SRF Theory, instantaneous symmetrical components	**12**
3	Utility- Customer Interface-Harmonic filter, Load compensation and voltage regulation using DSTATCOM,design of controllers for DSTATCOM	**10**
4.	Shunt, series, hybrid filters, sag and swell correction using DVR Power quality conditioners UPQC - Configuration and working	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	A. Ghosh and G. Ledwich, "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic.	2002
2.	G.T. Heydt. "Electric Power Quality", Stars in a Circle Publications (2nd Edition).	1994
3.	J. Arrillaga, N.R. Watson, S. Chen, Power System Quality Assessment, John Wiley & sons, New York.	2000
4.	Math H.J. Bollen, Understanding Power quality problems, IEEE Press, New York.	2000
5.	E. Acha, Manuel Madrigal, Power system Harmonics, John Wiley & sons, New York.	2001
6.	Moreno – Murioz (Ed), Power Quality (Mitigation Technologies in Distribution Environment Springer,	2007
7.	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad,"Power Quality Problems and Mitigation Techniques", John Wiley & Sons Ltd. 2015.	2015

Departmental Electives 2

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY-520	PMU & Wide area Monitoring system	**3**	**1**	**0**	PSY-503

Course Objective
To provide students with a comprehensive understanding of how PMUs function, including their principles of operation, applications in power systems, data analysis techniques, and their role in enhancing grid stability, monitoring, and control by precisely measuring voltage and current phasors across the electrical network using high-precision time synchronization.

Course Outcome(CO)

CO1: Understand basics concepts and algorithms related to synchrophasors,
CO2: Apply knowledge of PMU for the integration of wide area measurement systems
CO3: Knowledge of synchrophasor protocols
CO4: Dynamic analysis with synchrophasor technology

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**1**	**1**	**1**
CO2	**3**	**1**	**2**
CO3	**2**	**2**	**2**
CO4	**3**	**3**	**2**

Course Contents

Unit	Content	Contact Hours
1	Synchro phasor technology: Time-synchronized concepts and measurements, Global Positioning System (GPS), NTP, PTP. Synchrophasor application in power system;	**8**

2	PMU and it's principle of operation and estimation algorithms.. PMU specifications, selection of locations; C37.118 protocol and its version, Phasor Data Concentrator (PDC); Wide Area Measurement system (WAMS) visualization and monitoring concepts.	**12**
3	Application of synchrophasor technology: State estimation (SE) of state estimators; PMUs for rotor angle stability, voltage stability, fault assessments and oscillation monitoring.	**12**
4.	Wireless and wired communications (viz. PLCC,RF, WiFi, Optical fibre communication); communication flows; communication latency; advanced SCADA	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Synchronized Phasor Measurements and Their Applications by Arun G Phadke, James S Thorp, Springer.	2017
2.	Power System Grid Operation Using Synchrophasor Technology, Edited by Nuthalapati, Sarma, Springer.	2019
3.	Phasor Measurement Units and Wide Area Monitoring Systems byAntonello Monti , Carlo Muscas, Ferdinanda Ponci.	2016

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY-522	HVDC Transmission	3	0	2	PSY-501

Course Objective

To provide students with a comprehensive understanding of the principles, components, operation, and control mechanisms of HVDC transmission technology, including the conversion process between AC and DC, power flow management, harmonic mitigation, and fault analysis, enabling them to design and analyze efficient long-distance power transmission systems using HVDC technology.

Course Outcome(CO)

CO1: Requirement and importance of DC power transmission over ac transmission
CO2: Analyse of six pulse and twelve pulse converters
CO3: Procedure to Control HVDC system
CO4: Simulation analysis of Harmonics and filters design in HVDC

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	1	1	1
CO2	2	2	3
CO3	3	2	3
CO4	3	3	3

Course Contents

Unit	Content	Contact Hours
1	DC power transmission technology introduction-comparison of ac and dc transmission –application of dc transmission-description of dc transmission system, planning for hvdc transmission-modern trends in dc transmission.	10

2	Analysis of hvdc converter, pulse number, choice of converter configuration, simplified analysis of graetz circuit-converter bridge characteristics, characteristics of twelve pulse converter – detailed analysis of converters	**12**
3	Hvdc system control.,general principles of dc link control converter control characteristics-system control hierarchy –firing angle control-current and extinction angle control-starting and stopping of dc link power control	**10**
4.	Harmonics and filters, generation of harmonics-design of ac filters-dc filters, simulations of hvdc systems introduction, modeling of hvdc systems for digital dynamic simulation.	**10**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Padiyar, K.R. "HVDC power transmission systems", Wiley Eastern Limited, New Delhi 1990. First edition.	1990
2.	Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Wiley Interscience, New York, London, Sydney,1971.	1971
3.	Arrillaga, J., "High Voltage Direct Current Transmission", Peter Peregrinus, London,1983.	1983
4.	Hingorani N.G. and Gyugyi L., *Understanding Facts*, IEEE Press, New York	1999
5.	Begamudre R.D., *EHV AC Transmission Engineering*, 2nd Edn., Wiley Eastern Ltd., New Delhi, 1991.	1991

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY-524	EHVAC Transmission	**3**	**1**	**0**	PSY-501

Course Objective

To provide a comprehensive understanding of the design, analysis, and operation of Extra High Voltage AC (Alternating Current) transmission systems, including aspects like line parameters, corona effects, voltage gradients, electrostatic fields, traveling wave theory, and power flow control at very high voltage levels, enabling students to effectively design and troubleshoot such systems in power grids

Course Outcome(CO)

CO1: Describe and analyze corona effects in transmission lines
CO2: Understand the electrostatic field effects of EHV lines
CO3: Analyze compensation techniques for EHV lines
CO4: Understand the fundamentals of high voltage transmission

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**2**	**2**	**3**
CO2	**2**	**3**	**2**
CO3	**3**	**1**	**2**
CO4	**2**	**3**	**3**

Course Contents

Unit	Content	Contact Hours
1	Introduction Standard transmission Voltages- average values of line parameters- Power handling capacity and line loss, Costs of transmission lines and equipment.	**6**

2	Mechanical consideration in line performances. Corona Effects- Power losses and audible noise, I2R losses and corona loss, Attenuation of travelling waves due to corona loss, Audible noise generation and characteristics, limits of audible noise, Day Night equivalent noise level, Radio Interference, corona pulse generation and properties, Limits for Radio Interference Fields, CIGRE formula, RI excitation function. Measurement of RI, RIV and excitation function, Design of Filter.	**14**
3	Electrostatic Field of Ehv Lines – Capacitance of long object, calculations of electrostatic field of AC lines, effect of high electrostatic field on humans, animals and plants, Measurement of electrostatic field, electrostatic induction in unenergized circuit of DC line, Induced voltages in Insulated ground wires, electromagnetic interference.	**14**
4.	Compensation of Ehv Lines- Series and shunt compensation, problems due to series compensation, Sub-synchronous resonance and remedial measures	**8**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Begamudre, R.D., EHVAC Transmission Engineering, New Age .	2011
2.	Padiyar, K.R., HVDC Power Transmission Systems, Wiley Eastern Ltd.	2012
3.	Kimbark, E.W., Direct Current Transmission, John Wiley, U.S.A	1996
4.	Power Engineer's Handbook, Revised and Enlarged 6th Edition TNEB Engineers Association, October 2002.	2002

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY-526	Power System Transients	3	1	0	PSY-501

Course Objective

Provide students with a comprehensive understanding of rapid voltage and current fluctuations (transients) that occur in power systems due to events like switching operations or lightning strikes, enabling them to analyze the impact of these transients on system stability and design appropriate mitigation strategies, including insulation coordination and surge protection devices.

Course Outcome(CO)

CO1: Analyze abnormal switching transients in power systems
CO2: Understand the propagation of traveling waves on transmission lines
CO3: Model and analyze power system transients
CO4: Conduct case studies of transient events

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	2	2
CO2	1	1	2
CO3	3	2	2
CO4	3	3	3

Course Contents

Unit	Content	Contact Hours
1	Origin and nature of transients and surges. Fundamental concepts of RLC circuit analysis, application of Laplace transform, Simple switching transients, Effect of resistance on LC circuit transients, Abnormal switching transients.	10

2	Transients in three-phase circuits, Travelling waves on transmission lines, Lightning, Insulation coordination, Overvoltage protection, substation equipment, Lumped and distributed circuit representations. Line energization and de-energization transients,	**12**
3	Current chopping, short-line faults, trapped charge effects, effect of source, control of transients, lightning, effect of tower footing resistance.	**12**
4.	Travelling waves, insulation coordination, circuit breakers duty, surge arresters, overvoltage limiting devices, Case studies.	**8**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	Allan Greenwood, Electrical Transients in Power Systems, Wiley-Blackwell; 2nd Edition	1991
2.	Pritindra Chowdhuri, Electromagnetic Transients in Power Systems (High-Voltage Power Transmission), 2nd edition, PHI Learning	2008

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY-528	Grid Integration of Renewable Energy Systems	3	1	0	PSY-507

Course Objective

To provide a comprehensive understanding of the technical challenges and solutions involved in integrating variable renewable energy sources like solar and wind power into existing electricity grids, including analysis of their impact on power system operation, control strategies, and necessary grid modifications to ensure stability and reliable power delivery while maximizing renewable energy penetration.

Course Outcome(CO)

CO1: Understand the principles, requirements and challenges of the next generation future power network
CO2: Ability to model solar and wind energy system for dynamic analysis
CO3: Understand principles and limitations of complex power networks incorporating distributed generation
CO4: Develop concepts of imitation of conventional generation

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	2	2	1
CO2	3	3	2
CO3	3	3	3
CO4	2	2	2

Course Contents

Unit	Content	Contact Hours
1.	Various techniques of utilizing power from renewable energy sources, concept of micro grid and distributed generation. Need of integrating large renewable	4

	energy sources, issues related to integration of large renewable energy sources, rooftop plants.	
2.	Solar energy: Modelling of solar cells, optimal power extraction, shading, Stand alone and grid connected PV systems, storage.	**6**
3.	Wind Energy: Calculation of power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of four types of wind energy conversion systems.	**10**
4.	Grid tied inverter (GFL):Introduction, principles of power injection:voltage source converters, dq frame control, synchronisation, power flow; instantaneous active and reactive power control approach, dynamics of inverter control on grid oscillations, grid code and LVRT.	**12**
5.	Grid operation and control(GFM): Synchronisation, voltage control, frequency regulation, optimal generation dispatch, VSM and dynamics of low inertia systems.	**8**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	Om Prakash Mahela, Baseem Khan, Renewable Energy Integration in Utility Grids, Academic Press	2024
2.	Amirnasar Yazdani and Reza Iravani,Voltage sourced converter in power system, IEEE Press, Wiley	2010
3.	Lingling Fan and Zhixin Miao, Modelling and stability analysis of inverter based resources, CRC press	2024

Departmental Electives 3

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY-530	Optimization Techniques	**3**	**1**	**0**	Basic understanding of Power System

Course Objective

This course aims to equip students with the skills to analyze and solve both static and dynamic optimization problems in power systems. Students will learn to effectively plan and allocate power system resources, optimizing for efficiency and reliability. The course will also cover security-constrained optimization techniques to ensure the stability and security of the system under various conditions. Additionally, students will evaluate the impact of renewable generation on power system optimization, understanding how integration of renewable sources influences system performance and decision-making.

Course Outcome(CO)

CO1: Analyze and solve static and dynamic optimization problems
CO2: Analyze and plan power system resources
CO3: Understand and apply security-constrained optimization
CO4: Evaluate the impact of renewable generation on power system optimization

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**1**	**2**	**3**
CO2	**2**	**2**	**3**
CO3	**2**	**2**	**2**
CO4	**2**	**2**	**3**

Course Contents

Unit	Content	Contact Hours
1	Introduction to power system optimization problems and linkages. Optimization basics and solution techniques for convex and nonconvex optimization problems.	**6**
2	Static and dynamic optimization techniques. Basic Optimal power flow. Preventive and corrective security constrained optimal power flow,	**8**
3	Unit commitment, hydrothermal scheduling, generation, transmission and reactive expansion planning.	**8**
4	Optimization with uncertain data, Fuzzy and probabilistic techniques. Generation, transmission and reactive resources planning.	**12**
5.	Renewable generation integration optimization. Effect of markets and renewable generation in resources planning	**8**

Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Power generation operation and control, Wood and Woolenberg, WILEY	2013
2.	Optimization on Power system Operation by Jizhong Zhu Wiley-IEEE Press	2015
3.	S. S. Rao, "Optimization – Theory and Applications", Wiley Eastern Limited.	1984
4	Kalyanmoy Deb, "Optimization for Engineering Design – Algorithms and Examples", Prentice Hall India	2012
5	D.P. Kothari, "Power System Optimization", TMH	2004

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY-532	Forecasting Techniques	3	1	0	Basic understanding of Power System

Course Objective

This course aims to provide students with the knowledge and skills to evaluate and validate forecasting models, ensuring their accuracy and reliability. Students will explore the application of artificial intelligence techniques in forecasting, enhancing prediction capabilities. The course will also address key issues and challenges in the forecasting process, such as data quality and model limitations.

Course Outcome(CO)

CO1: Evaluate and validate forecasting model
CO2: Apply artificial intelligence techniques for forecasting
CO3: Address key issues and challenges in forecasting
CO4: Analyze and preprocess data for forecasting

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	1	1	3
CO2	2	2	3
CO3	2	2	2
CO4	3	3	2

Course Contents

Unit	Content	Contact Hours
1	Principles of forecasting load, wind and price. Statistical and non-statistical based approaches. AI application for forecasting.	6

2	Fundamentals of deregulated power market, Market time lines Forecast based decision time frames Principles of forecasting, Taxonomy of forecasting techniques, univariate/ multivariate forecasting, forecasting performance measurement. Statistical forecasting Overview of regression, time series techniques AR, MA, ARMA, ARMAX, ARIMA.	**10**
3	Artificial Intelligence Techniques: fundamentals, mathematical modeling Neural Networks Fuzzy Neural Networks Support Vector Machines Hybrid Techniques Load Forecasting: Key issues and challenges.	**8**
4	Data and feature selection, analysis and preprocessing, Price forecasting Key issues and challenges, price spikes and volatility analysis, Data selection, analysis and preprocessing, Feature selection, Modeling Model application and validation, Wind speed/power forecasting, ramp forecasting, Key issues and challenges.	**12**
5.	Uncertainty quantification of forecasts, Confidence/ Prediction Intervals, Future Scope and new challenges in emerging smart grid environment.	**6**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Mohammed Shahidehpour, Hatim Yamin, Zui Li, Market Operations in in Electric Power System: forecasting, scheduling and risk mangement, John Wiley & Sons Ltd	2002
2.	Rafal Weron, Modelling and Forecasting Electricity Loads and Prices: A statistical approach, John Wiley & Sons Ltd	2006
3.	G.P. Box and G.M. Jenkins, Time Series Analysis: Forecasting and Control, Holden-Day Inc.	1976
4	S. Makridakis, S.C. Wheelwright, R.J. Hyndman, Forecasting Methods and Applications, Wiley, 1998. 5. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, “An Introduction to Statistical Learning with Applications in R”, Springer.	2013

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY-534	Electricity Market Regulations & Trading	**3**	**1**	**0**	Basic understanding of power system

Course Objective

This course aims to provide students with a solid understanding of the principles underlying electricity markets and their functioning. Students will analyze various power trading mechanisms and how they impact market efficiency and pricing. The course will also cover market operations and the regulatory frameworks that govern them, ensuring a balanced and fair marketplace.

Course Outcome(CO)

CO1: Understand the principles of electricity markets
CO2: Analyze power trading mechanisms
CO3: Analyze market operations and regulation
CO4: Understand demand-side management and its role in electricity markets

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**1**	**2**	**2**
CO2	**2**	**3**	**1**
CO3	**2**	**3**	**2**
CO4	**2**	**3**	**2**

Course Contents

Unit	Content	Contact Hours
1	Electricity Market Structure, Power Exchanges and its working principle for power trading.	**8**

2	Power traders, electricity market clearing methodology, Power Purchase Agreements, Electricity pricing and trading, Demand side Management, Load frequency control, Long term- medium- short term open access in transmission.	**12**
3	Grid connectivity, Bilateral contracts, Intraday, day ahead and spot market, Spot and day energy accounting, , Ancillary Services.	**10**
4	Electricity Market Operators and Regulators, Regulations of electricity Utilities, T&D loss optimization, Integrating must run generation from RESs.	**12**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Fundamentals of Power System Economics by Daniel Kirschen & Goron Strbac, John Wiley & Sons, Ltd	2004
2.	Operation of Restructured Power Systems by Kankar Bhattaccharya, Math H. J.Bollen & Jaap E. Daalder, Kluwer Academic Publishers	2001
3.	Compendium of Regulations, Central Electricity Regulatory Commission, New Delhi.	2015

Course Title and Course Code		Course Structure			Prerequisite
		L	T	P	
PSY-536	Power System Planning	3	0	2	PSY501

Course Objective

This course aims to provide students with a comprehensive understanding of the fundamentals of power system planning, including the key concepts and strategies involved. Students will analyze electricity regulations and market structures, gaining insights into how these frameworks influence the planning and operation of power systems. Additionally, students will learn how to plan and design effective transmission and distribution networks, optimizing the delivery of electricity to end-users.

Course Outcome(CO)

CO1: Understand the fundamentals of power system planning
CO2: Analyze electricity regulations and market structures
CO3: Forecast electricity demand and assess resource adequacy
CO4: Plan and design transmission and distribution networks

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	1	1	3
CO2	2	2	2
CO3	2	2	3
CO4	3	2	3

Course Contents

Unit	Content	Contact Hours
1	Introduction-Power system planning, power system development and growth, power sources, planning tools.	8

2	Electricity regulations. Electricity Forecasting. Generation Planning. Transmission and distribution network planning.	**12**
3	New operation and planning policies. Allocation of reserve. Demand side bidding. Pricing schemes.	**10**
4	Competitive electricity markets. Environmental effects. Technology and Innovation (Modern Trends).	**12**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	Sullivan-"Power System Planning"., McGraw Hill.	1977
2.	Pabla, A.S., "Electric Power System Planning", Macmillan, India.	1998

Course Title and Course Code		Course Structure			Prerequisite
		L	**T**	**P**	
PSY-538	Substation Automation	**3**	**0**	**2**	PSY501

Course Objective

This course aims to provide students with a thorough understanding of data communication in power utilities, focusing on the systems that enable efficient operation and control. Students will analyze redundancy protocols used in substation networks to ensure reliability and minimize downtime. Additionally, students will gain a deep understanding of communication protocols specific to power utilities, enabling them to effectively manage and optimize utility communication systems.

Course Outcome(CO)

CO1: Understand Data Communication in Power Utilities
CO2: Analyze redundancy protocols for substation networks
CO3: Apply knowledge to practical substation automation scenarios
CO4: Understand communication protocols for power utilities

CO-PO Articulation metrics

Course	PO1	PO2	PO3
CO1	**1**	**1**	**2**
CO2	**2**	**2**	**3**
CO3	**3**	**2**	**2**
CO4	**2**	**2**	**2**

Course Contents

Unit	Content	Contact Hours
1	Substation components in conventional systems, Role of substation in power transfer and protection. Substation Automation in Transmission and Distribution Networks – Fundamentals.	**8**

2	Data Communication for Power Utilities – Fundamentals. Functions of Substation Automation Systems. Basics of Local Area Networks in digital substations: main components, operation of Ethernet switches, types of traffic, redundancy protocols (RSTP, PRP, HSR).	**12**
3	Time synchronization in digital substations: requirements and time synchronization protocols Communication Protocols for Power Utilities: Basic knowledge of IEC 61850: communication models, data model, System Configuration Language (SCL).	**10**
4	Configuration for Substation Automation System Digital substations implementation experience: architectures and LAN topologies, Practical example on how to configure merging unit to publish Sampled Values. Testing of digital substations	**12**

Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication / Reprint**
1.	Evilio Padilla "Substation automation system – Design and implementation" John Wiley & Sons Ltd.	2016