SWAMI VIVEKANAND SUBHARTI UNIVERSITY, MEERUT

FACULTY OF ENGINEERING & TECHONOLOGY

ORDINANCE No. V-42 (B3)

RELATING TO COURSE CURRICULUM & SYLLABUS OF PG PROGRAM

MASTER OF TECHNOLOGY (M.Tech.) PED

(Effective from the Session – 2025-26)

Apporved by the Academic Council of the Meeting held on 06 May 2025

Apporved by the Executive Council of the Meeting held on 28 June 2025

(Pankaj Gautam)

Ravi

(Er Ravi)

Ajay

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M. Tech. I Year/I Semester (POWER ELECTRONICS AND DRIVES) w.e.f. academic Session 2025-26

SEMESTER-I															
S. No.	Course Code	Course Name	Course Type	Periods			CCA					ESE		Total	Credit
				L	T	P	MT	P/A/Q	CP	Total	PS	TE	PE		
1	MPED-401	Advanced Semiconductor Devices	CC	3	1	0	15	10	5	30	-	70	-	100	4
2	MPED-402	Analysis of Power Converters	CC	3	1	0	15	10	5	30	-	70	-	100	4
3	MPED-403	Generalized Machine Theory	CC	3	1	0	15	10	5	30	-	70	-	100	4
4	MPED-404	Advanced Processors for Power Converters	CC	3	1	0	15	10	5	30	-	70	-	100	4
5	MPED-460	Seminar	Seminar	0	0	4	-	-	-	-	15	-	35	50	2
6	MPED-451	Analysis of Power Converters Lab	PC	0	0	8	-	-			30		70	100	4
	TOTAL													550	22

M. Tech. I Year/II Semester (POWER ELECTRONICS AND DRIVES) w.e.f. academic Session2025-26

SEMESTER II															
S. No.	Course Code	Course Name	Course Type	Periods			CCA					ESE		Total	Credit
				L	T	P	MT	P/A/Q	CP	Total	PS	TE	PE		
1	MPED-405	Switched Mode Power Supplies	CC	3	1	0	15	10	5	30	-	70	-	100	4
2	MPED-406	Industrial Electrical Drives	CC	3	1	0	15	10	5	30	-	70	-	100	4
3	MPED-407	Power Electronics Applications in Power Systems	CC	3	1	0	15	10	5	30	-	70	-	100	4
4	MPED-408	Special Machines and Control	CC	3	1	0	15	10	5	30	-	70	-	100	4
5	MPED-461	Constitution/ Moral/Human Values	CHM	0	0	4	7	4	4	15	-	35	-	50	2
6	MPED-452	Industrial Electrical Drives Lab	PC	0	0	8	-	-	-	-	30		70	100	4
	TOTAL													550	22

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M.Tech. II Year/III Semester (POWER ELECTRONICS AND DRIVES) w.e.f. academic Session 2025-26

SEMESTER III															
S. No.	Course Code	Course Name	Course Type	Periods			CCA					ESE		Total	Credit
				L	T	P	MT	P/A/Q	CP	Total	PS	TE	PE		
1	MPED -501	FACTS and Custom Power Devices	CC	3	1	0	15	10	5	30	-	70	-	100	4
2	MPED -502	Industrial Load Modeling and Control	CC	3	1	0	15	10	5	30	-	70	-	100	4
3	MPED -503	Discipline Elective Course-1	CC	3	1	0	15	10	5	30	-	70	-	100	4
4	MPED -504	Discipline Elective Course-2	CC	3	1	0	15	10	5	30	-	70	-	100	4
5	MPED -541	Open elective	OEC	2	0	0	7	4	4	15	-	35	-	50	2
6	MPED -551	Project work/ Practicum Course/ Dissertation	PC	0	0	8	-	-	-	-	30		70	100	4
7	MPED -552	Industrial Internship	PC	-	-	-	-	-	-	-	100	-	-	100	4
	TOTAL													650	26

M. Tech II Year/IV Semester (POWER ELECTRONICS AND DRIVES) w.e.f. academic Session 2025-26

SEMESTER IV															
S. No.	Course Code	Course Name	Course Type	Periods			CCA					ESE		Total	Credit
				L	T	P	MT	P/A/Q	CP	Total	PS	TE	PE		
1	MPED -505	Static VAR Controllers and Harmonic Filtering	CC	3	1	0	15	10	5	30	-	70	-	100	4
2	MPED -521	Discipline Elective Course-3	DEC	3	1	0	15	10	5	30	-	70	-	100	4
3	MPED -553	Dissertation or Project Work	Project	0	0	12	-	-	-	-	200		100	300	12
4	MPED -531	Employability & Entrepreneurship Skill Course	EEC	0	0	4	7	4	4	15	-	35	-	50	2
	TOTAL													550	22

Continuous Comprehensive Assessment (CCA)
Core Courses (CC);
Discipline Elective Courses (DEC);
Practicum Courses (PC);
Open Elective Courses (OEC);
Seminar; Constitutional, Human and Moral Values, and IPR (CHM);
Employability and Entrepreneurship Skill Courses (EEC)
P/A/Q: Presentation/ Assignment/ Quiz

M.TECH. (PED) TOTAL CREDITS– 92

COURSE CODE STRUCTURE FOR 1st Year (400 to 499)

As Per Ordinance given By SVSU

Courses	CODE	
	From	To
CC	400	420
DEC	421	430
EEC	431	440
OEC	441	450
PC	450	459
CHM	460	470

COURSE CODE STRUCTURE FOR 2nd Year (500-599)

Courses	CODE	
	From	To
CC	500	520
DEC	521	530
EEC	531	540
OEC	541	550
PC	550	559
CHM	560	570

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Discipline Elective-1: MPED-503

1: Switched Mode and Resonant Converters
2: Optimal and Adaptive Control
3: Power Quality
4: Dynamics of Electrical Machines

Discipline Elective-2: MPED-504

1: Static VAR Controllers and Harmonic Filtering
2: PWM converter and Applications
3: Power Semiconductor Devices & Modeling
4: Advanced Digital Signal Processing

Discipline Elective-3: MPED-521

1: Advanced Microcontroller based Systems
2: Distributed Generation
3: Smart Grids
4: SCADA Systems and Applications

Open Elective: MPED-541

1. Industrial Optimization Techniques

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Discipline Core

Course Code	Course Title	L	T	P	C
MPED-401	Advanced Semiconductor Devices	4	0	0	4

Course Objectives

1. To make the students understand the importance of appropriate devices selection based on the application requirements.
2. Understand the various power semiconductor device characteristics and significance of gate drive and protection circuits.

Expected Course Outcome

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

1. Identify and categorize power electronic switches based on its rating
2. Appropriate device selection suitable for application
3. Examine and classify various power semiconductor switching characteristics and summarize the voltage, current controlled devices
4. Analyze the characteristics of new emerging power semiconductor devices.
5. Design appropriate protection circuits to overcome problems associated with power electronic circuits.

Module:1	Semiconductor device selection	6 hours
Power switching devices overview; Attributes of an ideal switch; application requirements; circuit symbols; Power handling capability; Safe Operating Area; Devices election strategy: On-state and switching losses; EMI due to switching		

Module:2	Power Diodes	5 hours
Power diodes: Structure, operating principle, switching characteristics, types, forward and reverse characteristics; device datasheet; simulation of power diode characteristics		

Module:3	Power Thyristors	6 hours
PowerThyristors:Physicsofoperation,Twotransistoranalogy;conceptoflatching;Gateand switching characteristics; converter grade and inverter grade and other types; series and paralleloperation;steadystateanddynamicmodelsofThyristor;simulationofpowerthyristor characteristics		

Module:4	Power Transistors	6 hours
Power Transistors: Construction, static characteristics, physics of operation, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power Darlington; Safe operating regions; dynamic models of BJT; comparison of BJT and Thyristor; Simulation of power transistor characteristics.		

Module:5	Power MOSFETs and IGBTs	7 hours
Principle of voltage controlled devices: construction, in versionayer significance, types, static and switching characteristics; steady state and dynamic models of MOSFET and IGBTs; Simulation of power MOSFET and IGBT characteristics.		

Module:6	Emerging Power Devices	7 hours
Smart power devices; Intelligent Power Modules; Silicon Carbide Devices; Wide band gapdevices:Verticalandlateralstructures,Turn-onandTurn-offcharacteristicsofthedevice; Device data sheet		

Module:7	Gate Driving and Protection	6 hours
Isolationcircuits:pulsetransformer,opto-coupler;Gatedrivescircuit:semiconductordevices and wide bandgap power devices; Design of snubbers; Heat sink: selection, types and mounting types; simulation of gate drive circuits		

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Text Book(s)	
1.	NedMohan,ToreM.Undeland,"PowerElectronics-Converters,ApplicationsandDesign", JohnWiley&Sons,3rd edition2007.
2.	RashidM.H.,"PowerElectronics:Circuits,DevicesandApplications",PearsonEducation,4th editionJune2014.
Reference Books	
1.	F.Wang,Z.ZhangandE.A.Jones,CharacterizationofWideBandgapPowerSemiconductor Devices, IET, ISBN-13: 978-1785614910 (2018)
2.	B.J.Baliga, "Gallium Nitride and Silicon Carbide Power Devices," World ScientificPublishing Company (3 Feb. 2017).

RecommendedbyBoardofStudies			
ApprovedbyAcademicCouncil		Date	

Course Code	Course Title	L	T	P	C
MPED-402	Analysis of Power Converters	4	0	0	4

Course Objectives

1. To give asystematic approach for transient and steady state analysis of power electronic converters with passive and active loads.
2. Analyze the advanced converters such as multi-level inverters and compare different PWM techniques for their control.

Course Outcome

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

1. Understand the working principle and analyze different types of single-phase rectifiers.
2. Understand the working principle and analyze different types of three-phase rectifiers.
3. Analyze and design different configurations of DC–DC converters.
4. Classify various types of inverters and examine their harmonic performance.
5. Simulate various types of power electronic converters and evaluate their performance.

Module:1	SINGLEPHASECONTROLLEDRECTIFIER	7 hours

Single Phase AC to DC controlled converter configurations: Semi-converter and Fully controlled converter with R, RL, RLE load; Continuous and discontinuous conduction mode; Analysis of supply side power factor and power factor improvement techniques; Effect of source inductance; Dual converter; PWM rectifier

Module:2	THREE PHASE CONTROLLED RECTIFIER	8 hours

Three Phase AC to DC controlled converters configurations: Semi-converter and Fully controlled converter with R, RL, RLE load; Continuous and discontinuous conduction mode; Harmonic analysis; Effect of source inductance; Multi-quadrant converter; Multi-pulse converter

Module:3	DC-DC CONVERTERS	7 hours

Configurations:Buck,Boost,Buck-Boost;Multi-portandinterleavedconverters;Synchronous converters; Design and control of DC-DC converter; Multi-quadrant choppers and applications

Module:4	DC-AC INVERTERS	9 hours

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Inverters and AC Drives: Single-phase Voltage Source Inverter (VSI) and Current Source Inverter (CSI), three-phase VSI and CSI, 120° and 180° modes of operation, PWM techniques including Sinusoidal PWM (SPWM) and Space Vector PWM (SVPWM), multilevel inverters, types, voltage control and applications, harmonic spectrum, Total Harmonic Distortion (THD) analysis, harmonic mitigation techniques, filter design, and device selection.

Module:5	AC VOLTAGE CONTROLLERS	6 hours

Single phase and three phase voltage regulators; R and RL load, range of control; Single phase cycloconverters: Types and operating principle

Module:6	POWER CONVERTERS APPLICATION	6 hours

Applications of Power Electronic Converters: HVDC applications, front-end rectifier design, motor control applications, reactive power compensation, Uninterruptible Power Supply (UPS), induction heating, and the applications of power electronic converters in renewable energy systems and electric vehicles.

Textbook(s)

1.	RashidM.H.,"Power Electronics-Circuits, Devices and Applications", Prentice Hall India, New Delhi, 2017.
2.	Ned Mohan, Tore M. Undeland,"Power Electronics–Converters, Applications and Design", John Wiley&Sons, 2008.

Reference Books

1.	JosephVithayathil,"PowerElectronics–PrinciplesandApplications",TataMcGraw-Hill edition, 2010.
2.	BinWu, Mehdi Narimani,"High-PowerConvertersandACDrives",JohnWiley&Sons,2017.
3.	William Shepherd and Li Zhang, "Power Converter Circuits", Marcel Dekker Inc, New York, 2004.

Course code	Course Title	L	T	P	C
MPED-403	Generalized Machine Theory	3	1	0	4

Course Objectives

1. To impart knowledge of modern techniques and analytical methods for solving operational problems in electrical machines.
2. To develop research skills and the ability to identify and solve real-world problems related to electrical machines.

Course Outcome

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

1. Analyze the conversion and utilization of electrical energy in electromechanical energy conversion systems.
2. Apply the transformation of three-phase variables to two-phase axis models for machine analysis.
3. Comprehend the dynamic models of DC machines, synchronous machines, induction machines, and special electrical machines.
4. Explain the limitations of dynamic models of electrical machines.
5. Analyze the dynamic performance of interconnected electrical machines and drive systems.

Module:1	Principles of Electromagnetic Conversion	7 hours

Fundamentals of Electromechanical Energy Conversion: Single- and multiple-excited systems, field energy, co-energy and mechanical force, principles of electromechanical energy conversion, and torque and force expressions for single- and multiple-excited systems.

Module:2	Linear Transformation and Reference Frame Theory	9 hours

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Reference Frame Theory and Machine Transformations: Kron's theory, transformation from three-phase to two-phase variables, transformation from rotating axes to stationary axes, Park's transformation, physical interpretation of transformations, reference frame theory, transformation between reference frames, stationary circuit variable transformation, and steady-state voltage equations.		
Module:3	**DC Machine**	**8 hours**
Dynamic Analysis of DC Machines: Analysis of DC machines using the primitive machine equations, steady-state and transient analysis, and transfer function models of DC generators and DC motors.		
Module:4	**Modelling of Induction Machine**	**8 hours**
Dynamic Modeling of Induction Machines: Voltage and torque equations, machine variables, arbitrary and rotor reference frames, steady-state operation, dynamic modeling of induction machines, operation under non-sinusoidal supply waveforms, and simulation of arbitrary reference frame and linearized models.		
Module:5	**Modelling of Synchronous Machine**	**9 hours**
Dynamic Modeling of Synchronous Machines: Reactance and time constants of synchronous machines, voltage and torque equations, machine variables, arbitrary and rotor reference frames, Park's equations, dynamic modeling of synchronous machines, effects of magnetic saturation, and simulation of linearized models.		
Module:6	**Modelling of Special Machines**	**9 hours**
Dynamic Modeling of Special Electrical Machines: Steady-state and dynamic modeling of Permanent Magnet Synchronous Machines (PMSM) and Brushless DC (BLDC) motors, and steady-state and dynamic modeling of Switched Reluctance Motors (SRM).		
Module:7	**Modelling of Interconnected machines**	**8 hours**
Dynamic Analysis of Interconnected Machines: Dynamic analysis of interconnected electrical machines, machine interconnection matrices, transformation of voltage and torque equations using interconnection matrices, and large-signal transient analysis using transformed equations.		

Text Book(s)	
1.	KrausePC,WasynczukO,SudhoffSD(2013)Analysisofelectricalmachineryanddrive systems,3rdedition.IEEEPress
2.	.BimalK.bose,(2015),ModernPowerElectronicsandACDrives,PrenticeHall.
Reference Books	
1.	R.Krishnan,(2015)Electricmotordrives,modeling,analysisandcontrol,Pearson.
2.	A.E.Fitzgerald,CharlesKingsleyandStephen D.Umans,(2020),ElectricMachinery,Mc GrawHill,IndianEdition.
3.	IonBoldea,(2017)Variablespeedgenerators,CRCPress.

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Course Code	Course Title	L	T	P	C
MPED-404	Advanced Processors for Power Converters	4	0	0	4

Course Outcome

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

1. Understand the ARM processor architecture and its programming fundamentals.
2. Use timers and PWM modules to generate triggering pulses for power electronic circuits.
3. Implement ARM processor exception handling to vary triggering pulses for power electronic circuits.
4. Apply digital signal processing techniques using ARM processors.
5. Experiment with the peripherals of DSP processors for power electronics applications.

Module:1	ARM Processors	5 hours

ARM Processor Architecture: ARM processor architecture and pipelining, programmer's model, datapaths and instruction decoding, Advanced Microcontroller Bus Architecture (AMBA), ARM instruction set, addressing modes, General Purpose Input/Output (GPIO), Analog-to-Digital Converter (ADC), Digital-to-Analog Converter (DAC), and simple programming.

Module:2	Timers and PWM	6 hours

Timers and PWM Generation: Different modes of operation of timers, match registers, generation of PWM using compare registers, capture control, single-edge and double-edge controlled PWM, and programming for generating triggering pulses for power electronic converters.

Module:3	Component Interfacing and Networks	6 hours

ARM System Control and Communication Interfaces: System control, Real-Time Clock (RTC), Watchdog Timer (WDT), USB 2.0 Full-Speed Device Controller with DMA, communication interfaces including UART, I^2C bus serial interface, SPI, and SSP serial interfaces.

Module:4	Exception and Interrupt Handling	6 hours

Exception Handling and Interrupt Programming: Exception handling overview, interrupts, interrupt handling schemes, external interrupts, timer interrupts, PWM interrupts, ADC interrupts, applications of interrupts in the closed-loop control of real-time systems, and interrupt programming.

Module:5	Digital Signal Processing with ARM	6 hours

Digital Signal Processing on ARM: Representation of digital signals, introduction to digital signal processing (DSP) on ARM processors, and industrial requirements for digital implementation using ARM-based processors.

Module:6	Digital Signal Processor	9 hours

DSP Processor Architecture and Programming: Basic architecture, system configuration registers, memory addressing modes, interrupt handling, instruction set, programming concepts, simple programs, General Purpose Input/Output (GPIO) functionality, utilization of GPIO in PWM signal generation, interrupts, Analog-to-Digital (A/D) converter, Event Managers (EVA and EVB), and PWM signal generation for single-phase inverters.

Module:7	Real Time Digital Signal Processing	5 hours

Sample Based Processing; Frame Based Processing; Basic Buffer Structures; Usage of Buffers in Frame-Based Processing; Overlap Methods for Frame-Based Processing

Textbook(s)

1.	AndrewN.Sloss,DominicSymes,ChrisWright,"ARMSystemDeveloper'sGuideDesigningand Optimizing System Software" Morgan Kaufmann Publishers, 2011.

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2.	Hamid A. Toliyat, Steven Campbell, "DSP based electromechanical motion control", CRC press, New York, Washington Dc, 2012.
Reference Books	
1.	William Hohl, Christopher Hinds "ARM Assembly Language – Fundamentals and Techniques" Second Edition, CRC Press Taylor & Francis Group 2015.

Course Title	L	T	P	C
MPED-451-Analysis of Power Converters Lab	0	0	8	4

List of Experiments – Power Electronics Laboratory

1. Implementation of driver circuits for power switching devices (SCR, MOSFET, and IGBT).
2. Estimation of losses and thermal performance of power converters.
3. Study of switching characteristics and driver circuits for wide bandgap (WBG) devices.
4. Performance analysis of single-phase controlled AC–DC one-pulse converter.
5. Performance analysis of single-phase controlled AC–DC two-pulse converter with R and RL loads.
6. Performance analysis of three-phase controlled AC–DC six-pulse converter with R and RL loads.
7. Performance analysis of AC–AC voltage regulator.
8. Performance analysis of AC–AC cycloconverter.
9. Voltage control of single-phase inverter with R and RL loads.
10. Implementation and performance analysis of three-phase inverter with R load.
11. Duty ratio control of DC–DC converters (Buck, Boost, and Buck–Boost).
12. Implementation of multi-quadrant chopper.
13. PWM control of DC–AC inverters.
14. Harmonic mitigation in Voltage Source Inverters (VSI).
15. Implementation and analysis of power factor correction (PFC) circuit.

Textbook(s)	
1.	RashidM.H.,"PowerElectronics-Circuits,DevicesandApplications",PrenticeHallIndia,New Delhi, 2017.
2.	Ned Mohan, Tore M. Undeland, "Power Electronics – Converters, Applications and Design", John Wiley & Sons, 2008.
Reference Books	
1.	Joseph Vithayathil,"Power Electronics–Principles and Applications",TataMcGraw-Hill edition, 2010.
2.	BinWu, Mehdi Narimani ,"High-Power Converters and AC Drives",John Wiley & Sons, 2017.

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SEMESTER-II

Course Code	Course Title	L	T	P	C
MPED-405	Switched Mode Power Supplies	3	1	0	4

Course Outcome

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

1. Analyze different non-isolated DC–DC converters under steady-state operating conditions.
2. Develop circuit models for different DC–DC converters.
3. Compare isolated and non-isolated DC–DC converters.
4. Design magnetic components for DC–DC converters.
5. Develop dynamic and small-signal models of switched-mode power converters.

Module:1	Non-Isolated DC-DC converters	5 hours
Steadystateanalysis:idealBuck,Boost,Buck–BoostandCukConverters(CCMandDCM), operating principles, constituent elements, characteristics, comparisons and selection criteria		

Module:2	Modelling and Analysis of Non-Isolated converters	4 hours
Steady state analysis: non-ideal Buck, Boost, Buck–Boost and Cuk Converters, losses and efficiency		

Module:3	Isolated converters	4 hours
Significance of isolated converters; Steady State Analysis: Forward Converter, Fly-back Converter, Push pull, Half and full bridge Converter		

Module:4	Magnetic circuit Design	4 hours
Design of high-frequency inductors, transformers, and capacitors for Switched-Mode Power Supply (SMPS) applications, and input filter design.		

Module:5	Dynamic Analysis and Control of Switching Converters	5 hours
AC equivalent circuit modeling of DC–DC converters, dynamic equations of Buck, Boost, and Buck–Boost converters, small-signal modeling and converter transfer functions, control of DC–DC converters, voltage-mode and current-mode control, and PWM controller integrated circuits (ICs).		

Module:6	Resonant Converters	3 hours
Classification of resonant converters, series resonant circuits, parallel resonant circuits, resonant switches, zero-voltage switching (ZVS), zero-current switching (ZCS), and soft-switched bidirectional dual active bridge (DAB) converters.		

Module:7	Applications of SMPC	3 hours
Power Factor Correction in Switching Power Supplies: Low Input SMPS for Laptop Computers and PortableElectronicdevices,EVchargingsystems;Casestudies:SMPCsimulationusingopen Source tools		

Textbook(s)

1.	RobertW.EricksonandDraganMaksimovic,"FundamentalsofPowerElectronics",Springer, 3rdedition, 2020.
2.	SimonAng,AlejandroOliva,"Power-SwitchingConverters",CRCPress,Vol.No., 3rd Edition, 2010.

Reference Books

1.	PhilipTKrein,"ElementsofPowerElectronics",OxfordUniversityPress,2ndEdition, 2017.
2.	NedMohan,UndelandandRobbin,"PowerElectronics3ed(AnIndianAdaptation): Converters, Application and design "Wiley India Pvt Ltd, 3rdEdition, 2022.

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Course Code	Course Title	L	T	P	C
MPED-406	Industrial Electrical Drives	3	1	0	4

Course Objectives

1. To introduce basic concepts of load and drive interaction, speed control concepts of ac and dc drives, speed reversal, regenerative braking aspects, design methodology.
2. To analyze electromagnetic interference (EMI) and mitigate harmonics in energy-efficient electric drives.

Expected Course Outcome

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

1. Describe the dynamics of electric drives and identify suitable power converter ratings.
2. Classify different types of DC drives and design their control schemes.
3. Classify different types of AC drives and design their control schemes.
4. Summarize EMI/EMC standards and various energy-saving schemes used in electric drives.

Module:1	Drive Dynamics and Power Ratings	7 hours

Dynamics and Selection of Electric Drives: Dynamics of electric drives, multi-quadrant operation, moment of inertia, torque and power for rotational and linear motion loads, selection of motor power rating, classes of duty, thermal models (heating and cooling), selection of power converters, direct converters, converters with intermediate circuits, converter rating based on motor specifications, factors affecting drive selection, overload capacity, control range, derating factor, and efficiency.

Module:2	Control of DC Motor Drive	6 hours

DC Motor Drives: Factors governing the speed and torque of DC motors, controlled rectifier-based speed control, single-quadrant, two-quadrant, and four-quadrant controlled DC motor drives, chopper-fed speed control with four-quadrant operation, and closed-loop control of DC motor drives.

Module:3	Control of Induction Motor Drive	7 hours

Induction Motor Drives: Characteristics and equivalent circuit of poly-phase induction motors, stator-side control, speed control techniques including stator voltage control, variable frequency control, and V/f control, soft starting methods, braking methods, rotor-side control, static rotor resistance control, Kramer drive, Scherbius drive, and doubly fed induction motor (DFIM) drive.

Module:4	Vector Control of Induction Motor Drive	8 hours

Principle of vector control, types of vector control, direct vector control, indirect vector control, rotor flux-oriented control, stator flux-oriented control, air gap flux-oriented control, decoupling circuits- speed sensor less control, Concept of space vectors, DTC control strategy of induction motor

Module:5	Control of Synchronous Machine Drives	7 hours

Steady-state equivalent circuits and dynamic model of synchronous machine; Zero d-axis current control, maximum torque per ampere control, direct torque control, and power factor control

Module:6	Electromagnetic Interference and Harmonics	4 hours

Introduction to EMI and EMC, EMC for power converters, grounding and shielding, EMC classes andStandards;Introductiontoharmonics,harmonicmeasurementtechniques,reductionmethods-mitigation tools

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Module:7	Energy Saving in Electric Drives	4 hours
Energy-Efficient Electrical Drives: Classification of energy efficiency, energy-efficient motor starting and control, load over time and load characteristics, applications with variable torque and constant torque loads, life cycle cost (LCC) analysis, and system savings using regenerated power.		

Textbook(s)	
1.	BimalKBose,"ModernPowerElectronicsandACDrives",PearsonEducationAsia,2012.
2.	R. Krishnan, Electric Motor Drives: Modelling, Analysis, and Control, 2015, Second edition, Pearson Education India.
Reference Books	
1.	GopalKDubey,"FundamentalsofElectricalDrives",CRCPress,SecondEdition,2015.
2.	Petervas,Vector control of AC Machines–Oxforduniversitypress,1990.
3.	R.RajaSingh,EnergyConservationStrategiesforAsynchronousMachineDrives,Lap Lambert Academic Publishing, Germany, 2021..
4.	Danfoss Handbook on VLT Frequency Converters, "Facts Worth Knowing about Frequency Converters", PE-MSMBM Publications, 2014.
5.	T.J.EMiller,"BrushlessPermanentMagnetandReluctanceMotorDrives",ClarendonPress, Oxford1989.

Course Code	Course Title	L	T	P	C
MPED-407	Power Electronics Application in Power Systems	3	1	0	4
		Syllabus version			
		1.0			

Course Objectives

1. To impart in-depth knowledge of reactive power control and the applications of FACTS controllers.
2. To bring out the importance of Flexible AC Transmission Systems (FACTS) and their controllers..

Course Outcome

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

1. Apply the concepts of load compensation and reactive power control in AC power systems.
2. Analyze the operation, modeling, and performance of shunt and series FACTS devices.
3. Explain the operating principle, modeling, and control structure of the Phase Angle Regulator (PAR) and Unified Power Flow Controller (UPFC).
4. Apply FACTS controllers for improving the performance and control of transmission systems.
5. Demonstrate comprehensive knowledge of line-commutated converters (LCC) and modular multilevel converters (MMC) used in HVDC systems.

Module:1	Transmission System Compensation	6hours
Power Flow in AC Systems : importance of controllable parameters, stability Limits; Theory of static shunt and series compensation		
Module:2	**SVC and STATCOM**	**6hours**

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Shunt Compensation, Objectives of Shunt Compensation, Static Var Compensator (SVC), Comparison of Different SVC Configurations, Voltage Control Using SVC, Static Synchronous Compensator (STATCOM), V–I Characteristics, Dynamic Reactive Power Compensation Using STATCOM.		
Module:3	**TCSC and SSSC**	**6hours**
Need for variable series compensation ; TCSC: modelling of TCSC, operating control scheme, sub synchronous characteristics; SSSC: control range and VA rating		
Module:4	**Phase angle Regulator**	**6hours**
Objectives of voltage and phase angle regulator : Thyristor controlled voltage and phase angle regulators ;Switching converter based voltage and phase angle regulator		
Module:5	**Unified Power flow controller**	**6hours**
Operating Principle: control structure, Performance analysis		
Module:6	**Application of FACTS Devices**	**6hours**
Sub-synchronous resonance, Damping oscillations, Transient stability and voltage stability; Coordination of FACTS		
Module:7	**High Voltage DC Transmission**	**7hours**
Analysis of HVDC Converter :Line commutated converters and Modular Multilevel converters		
Textbook(s)		
1.	Narain G. Hingorani and László Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, Standard Publishers & Distributors, 2011.	
2.	R. Mohan Mathur and Rajiv K. Varma, *Thyristor-Based FACTS Controllers for Electrical Transmission Systems*, John Wiley & Sons, 2001.	
ReferenceBooks		
1.	T.J.E Miller " Reactive Power Control in Electric system" John Wiley & Sons, NY, 2010.	
2.	Enrique Acha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Pérez, "FACTS:Modellingand Simulation in Power Networks", John Wiley, 2011.	
3.	K.R.Padiyar, "FACTS controllers in Power transmission and disribution" ,New Academic Science,2011	
4.	Dragan Jovcic, "High Voltage Direct Current Transmission: Converters, Systems and DC Grids",2019,WileyPublications	

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Course Code	Special Machines and Control	L	T	P	C
MPED-408		3	1	0	4

Course Objectives:

1. To impart knowledge on special types of electromechanical energy conversion machines and their importance.
2. To select the appropriate special machine drive for specific applications.

Expected Course Outcome:

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

1. Analyze the properties of permanent magnet materials and magnetic circuits.
2. Interpret the construction, operation, and drive circuits of stepper motors.
3. Differentiate switched reluctance motors from synchronous reluctance motors.
4. Analyze square-wave and sine-wave permanent magnet brushless motor drives.
5. Appraise advanced synchronous motors and explain the development of linear motors from conventional rotating motors.

Module:1	Stepper Motors	6hours
Constructional and working; Modes of excitation: Drive circuits, Control Aspects; Concept of lead angle		
Module:2	**Switched Reluctance Motors**	**6hours**
Constructional and working; Power Converters and controllers; Methods of rotor position sensing.		
Module:3	**Synchronous Reluctance Motors**	**6hours**
Constructional and working; Significance of direct and quadrature inductances; Phasor diagram		
Module:4	**Permanent Magnet Brushless DC Motors**	**8hours**
Permanent Magnet materials, Magnet Characteristics, Permeance coefficient; Magnetic circuit analysis of PMBLDC;EMF and torque equations; Power Converters; Hall-effect sensor; Commutation; closed loop control		
Module:5	**Permanent Magnet Synchronous Motors**	**7hours**
Principle of operation; EMF and Torque equations; Synchronous Reactance; Phasor diagram; Converter Volt-ampere requirements		
Module:6	**Advanced Synchronous Machines**	**5hours**
Construction and working: Flux Switching and Flux Reversal Machines, Claw Pole Alternators, Axial flux Machine; applications		
Module:7	**Linear Motors**	**5hours**
Construction and working: Linear DC Motors, Linear Induction Motors, Linear Synchronous Motors, Linear Switched Reluctance Motors; applications		

Text Book(s)	
1.	T.J.EMiller,"BrushlessPermanentMagnetandReluctanceMotorDrives",ClarendonPress, Oxford1989.
2.	R.Krishnan,"PermanentMagnetandBrushlessDCMotorsDrives",CRCPress,NewYork, 2010.

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Course Code	Course Title	L	T	P	C
MPED-452	Industrial Electrical Drives Lab	0	0	8	4

Course Objectives

1. To understand the performance of electrical drives experimentally under various operating conditions.
2. To implement various speed control strategies for electric drives.

Expected Course Outcome

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

1. Design and conduct experiments, and analyze as well as interpret the experimental data.

List of Experiments – Electrical Drives Laboratory

1. Design and speed control of AC–DC converter-fed DC motor drive.
2. Design and speed control of DC–DC converter-fed DC motor drive.
3. Design and control of DC motor drive under four-quadrant operation.
4. Design and control of AC–AC regulator-fed induction motor drive.
5. Speed control of induction motor drive using V/f control.
6. Speed control of induction motor drive using VVC+ (Voltage Vector Control).
7. Speed control of induction motor drive using Field-Oriented Control (FOC).
8. Speed control of induction motor drive using flux sensorless control.
9. Dynamic braking of induction motor drive.
10. Automatic motor adaptation for machine parameter estimation and identification.
11. Performance analysis of induction motor drive under regenerative loading.
12. Speed control of slip-ring induction motor using static rotor resistance control.
13. Speed control of Permanent Magnet Synchronous Motor (PMSM) drive.
14. Speed control of synchronous motor drive using PI/PID controller.
15. Speed control of Synchronous Reluctance Motor (SynRM) drive.
16. Performance analysis of PMSM drives under regenerative loading.
17. Performance analysis of SynRM drive under regenerative loading.
18. Speed control using Static Kramer Drive and Static Scherbius Drive.
19. Performance analysis of Doubly Fed Induction Motor (DFIM).
20. Measurement of drive power and harmonic analysis.

Textbook(s)	
1.	Bimal K Bose, "Modern Power Electronics and AC Drives" ,Pearson Education Asia,2012.
2.	R. Krishnan, Electric Motor Drives: Modelling, Analysis, and Control,2015, Second edition, Pearson Education India.
Reference Books	
1.	Gopal K Dubey, "Fundamentals of Electrical Drives",CRC Press, Second Edition, 2015.
2.	Petervas, Vector control of AC Machines–Oxford university press,1990.

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SEMESTER-III

Course Code	Course Title	L	T	P	C
MPED-501	FACTS AND CUSTOM POWER DEVICES	3	1	0	4

1. Course Outcomes:

At the end of this course, students will be able to:

1. Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.
2. Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled.
3. Reactive Power Systems, PWM Inverter based Reactive Power Systems and their controls.
4. To develop analytical modeling skills needed for modeling and analysis of such Static VAR Systems.

Detailed Syllabus:

Unit I:

Reactive power flow control in Power Systems – Control of dynamic power unbalances in Power System. Power flow control -Constraints of maximum transmission line loading –Benefits of FACTS Transmission line compensation. Uncompensated line –Shunt compensation - Series compensation –Phase angle control. Reactive power compensation. Shunt and Series compensation principles – Reactive compensation at transmission and distribution level.

Unit II:

Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM - Compensator control. Comparison between SVC and STATCOM.

Unit III:

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators –TCVR and TCPAR Operation and Control –Applications, Static series compensation – GCSC,TSSC, TCSC and Static synchronous. series compensators and their Control.

Unit IV:

SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPF. Basic Principle of P and Q control- Independent real and reactive power flow control- Applications.

Unit V:

Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers – Simulation of FACTS controllers Power quality problems in distribution systems, harmonics. Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering– shunt , series and hybrid and their control.
Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality.

Suggested Reading:

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.
2. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control",Springer Verlag, Berlin, 2006.
3. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.

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4. K.S.Sureshkumar, S.Ashok , "FACTS Controllers & Applications", E-book edition, Nalanda Digital Library, NIT Calicut, 2003.
5. G. T.Heydt, "Power Quality", McGraw-Hill Professional, 2007.
6. T. J. E. Miller, "Static Reactive Power Compensation", John Wiley and Sons, Newyork, 1982.

Course Code	Course Title	L	T	P	C
MPED-502	INDUSTRIAL LOAD MODELING AND CONTROL	3	1	0	4

Course Outcomes:

Students will be able to:

1. Knowledge about load control techniques in industries and its application.
2. Different types of industrial processes and optimize the process using tools like LINDO and LINGO.
3. Apply load management to reduce demand of electricity during peak time.
4. Apply different energy saving opportunities in industries.

Syllabus:

Unit I:

Electric Energy Scenario-Demand Side Management-Industrial Load Management. Load Curves-Load Shaping Objectives-Methodologies. Barriers; Classification of Industrial Loads Continuous and Batch processes -Load Modeling.

Unit II:

Electricity pricing – Dynamic and spot pricing –Models. Direct load control- Interruptible load control. Bottom up approach- scheduling- Formulation of load models- Optimization and control algorithms - Case studies.

Unit III:

Reactive power management in industries-controls-power quality impacts application of filters Energy saving in industries.

Unit IV:

Cooling and heating loads- load profiling- Modeling. Cool storage-Types- Control strategies. Optimal operation-Problem formulation- Case studies.

Unit V:

Captive power units- Operating and control strategies- Power Pooling- Operation models. Energy banking-Industrial Cogeneration

Unit VI:

Selection of Schemes Optimal Operating Strategies. Peak load saving-Constraints-Problem formulation- Case study. Integrated Load management for Industries.

Suggested reading:

1. C.O. Bjork "Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989.
2. C.W. Gellings and S.N. Talukdar, "Load management concepts," IEEE Press, New York, 1986, pp. 3-28.
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981.
4. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Inter-science Publication, USA, 1989.
5. I. J. Nagarath and D. P. Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995.
6. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.

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Course Code	Course Title	L	T	P	C
MPED-505	STATIC VAR CONTROLLER AND HARMONIC FILTERING	3	1	0	4

Course Outcomes

Students will be able to:

1. Acquire knowledge about the fundamental principles of Passive and Active Reactive PowerCompensation Schemes at Transmission and Distribution level in Power Systems.
2. To introduce the student to various single phase and three-phase Static VAR Compensationschemes and their controls.
3. To develop analytical modeling skills needed for modeling and analysis of such Static VAR

Syllabus

Unit-I:

Fundamentals of Load Compensation. Steady-State Reactive Power Control in Electric Transmission Systems. Reactive Power Compensation and Dynamic Performance of Transmission Systems.

Unit-II:

Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion. Current Harmonics. Sources of Harmonics in Distribution Systems and Ill Effects .

Unit-III:

Static Reactive Power Compensators and their control. Shunt Compensators. SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control. Series Compensators of thyristor Switched and Controlled Type and their Control. SSSC and its Control, Sub-Synchronous Resonance and damping. Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power System.

Unit-IV:

Converters for Static Compensation. Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM). GTO Inverters. Multi-Pulse Converters and Interface Magnetics. Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM). Multi-level inverters of Cascade Type and their modulation. Current Control of Inverters.

Unit-V:

Passive Harmonic Filtering. Single Phase Shunt Current Injection Type Filter and its Control. Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modeling. Three phase four wire shunt active filters. Hybrid Filtering using Shunt Active Filters. Dynamic Voltage Restorer and its control. Power Quality Conditioner.

Unit-VI:

Series Active Filtering in Harmonic Cancellation Mode. Series Active Filtering in Harmonic Isolation Mode.

Suggested reading

1. Ned Mohan et.al, "Power Electronics",John Wiley and Sons,2006.
2. G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc., 1988.
3. B. J. Baliga," Power Semiconductor Devices",Thomson, 2004
4. V. Benda, J. Gowar, D. A. Grant," Power Semiconductor Devices. Theory and Applications",JohnWiley& Sons1994.

Manoj Kapil

Departmental Elective-1: MPED-503

Course Code	Course Title	L	T	P	C
MPED-503	SWITCHED MODE AND RESONANT CONVERTERS	3	1	0	4

Course Outcomes:

1. Acquire knowledge about the principles of operation of non-isolated and isolatedhard-switched DC-DC converters.
2. Acquire knowledge on various loss components in a switched mode converter and choice of switching frequency with a view towards design of such converters.

Syllabus:

Unit I:
Buck, Boost, Buck-Boost SMPS Topologies. Basic Operation-Waveforms - modes of operation -switching stresses. Switching and conduction losses. Optimum switching frequency. Practical voltage, current and power limits - design relations.

Unit II:
Transformer Design. Output Filter Design. Switching Stresses and Losses. Forward Converter Magnetics. Voltage Mode Control. Half and Full Bridge Converters. Basic Operation and Waveforms. Magnetics, Output Filter, Flux Imbalance, Switching Stresses and Losses, Power Limits, Voltage Mode Control.

Unit III:
Classification of Resonant Converters. Basic Resonant Circuit Concepts. Load Resonant Converter, Resonant Switch Converter, Zero Voltage Switching Clamped Voltage Topologies. Resonant DC Link Inverters with Zero Voltage Switching. High Frequency Link Integral Half Cycle Converter. Fly back Converter discontinuous mode operation, waveforms, control.

Unit IV:
Voltage Mode Control of SMPS- Loop Gain and Stability Considerations. Error Amp– frequency Response and Transfer Function. Trans-conductance Current Mode Control of SMPS. Current Mode Control Advantages, Current Mode Vs Voltage Mode.

Unit V: Current Mode Deficiencies. Slope Compensation. Study of a typical Current Mode PWM Control IC UC3842. Modeling of SMPS. Small Signal Approximation- General Second Order Linear Equivalent Circuits. Study of popular PWM Control ICs (SG 3525,TL 494,MC34060 etc.)

Unit VI:
DC Transformer, Voltage Mode SMPS Transfer Function. General Control Law Consideration. EMI Generation and Filtering in SMPS - Conducted and Radiated Emission Mechanisms in SMPS. Techniques to reduce Emissions, Control of Switching Loci. Shielding and Grounding, Power Circuit Layout for minimum EMI. EMI Filtering at Input and Output, Effect of EMI Filter on SMPS Control Dynamics.

Suggested reading:

1. Abraham I Pressman, “Switching Power Supply Design,”. McGraw Hill Publishing Company, 2001.
2. Daniel M Mitchell,“DC-DC Switching Regulator Analysis,” McGraw Hill Publishing Company-1988.
3. Ned Mohan et.al, “Power Electronics,” John Wiley and Sons 2006.

Course Code	Course Title	L	T	P	C
MPED-503	OPTIMAL AND ADAPTIVE CONTROL	3	1	0	4

Course Outcomes:

Students will be able to:

1. Knowledge in the mathematical area of calculus of variation so as to apply the same for solving optimal control problems.
2. Problem formulation, performance measure and mathematical treatment of optimal control problems.
3. Acquire knowledge on solving optimal control design problems by taking into consideration the physical constraints on practical control systems.
4. To obtain optimal solutions to controller design problems taking into consideration the limitation on control energy in the real practical world.

Syllabus

Unit-I:

Basics of the Optimal Regulator, standard regulator problem, Hamilton –Jacobi equation, tracking systems.

Unit-II:

Regulator Systems with a Classical Control Interpretation, Asymptotic Properties and Quadratic Weight Selection

Unit-III:

State Estimator Design, System Design Using State Estimators, the separation theorem and performance calculation

Unit-IV:

Classical and linear quadratic methods, Frequency Shaping and Digital Controllers with filters

Unit-V:

Adaptive Control: Introduction, Basic Adaptive Control Schemes & Applications, Parameter Adaptation Algorithms for Deterministic & Stochastic Environment

Unit-VI:

Direct Adaptive Control & Indirect Adaptive Control systems

Suggested reading:

1.Donald E. Kirk, "Optimal Control Theory, An introduction", Prentice Hall Inc., 2004.
2. A.P. Sage, "Optimum Systems Control", Prentice Hall, 1977.
3. HSU and Meyer , "Modern Control, Principles and Applications", McGraw Hill, 1968. 4.Yoan D. Landu, "Adaptive Control (Model Reference Approach)", Marcel Dekker. 1981.
5. K.K.D.Young, "Design of Variable Structure Model Following Control Systems", IEEE. 6.
Transactions on Automatic Control, Vol. 23, pp 1079-1085, 1978.

Course Code	Course Title	L	T	P	C
MPED-503	POWER QUALITY	3	1	0	4

Course Outcomes:

Students will be able to:

1. Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads develop analytical modeling skills needed for modeling and analysis of harmonics innetworks and components.
2. To introduce the student to active power factor correction based on static VAR compensators and its control techniques.
3. To introduce the student to series and shunt active power filtering techniques for harmonics.

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Unit-I:

Introduction-power quality-voltage quality-overview of power Quality phenomena classification of power quality issues. Power quality measures and standards-THD-TIF-DIN-C-message weights. Flicker factor transient phenomena-occurrence of power quality problems Power acceptability curves-IEEE guides Standards and recommended practices.

Unit-II:

Harmonics-individual and total harmonic distortion RMS value of a harmonic waveform Triplex harmonics. Important harmonic introducing devices. SMPS Three phase power converters-arcing devices saturable devices Harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

Unit-III:

Modeling of networks and components under non-sinusoidal conditions. Transmission and distribution systems. Shunt capacitors-transformers. Electric machines. Ground systems loads that cause power quality problems. Power quality problems created by drives and its impact on drive.

Unit-IV:

Power factor improvement- Passive Compensation. Passive Filtering. Harmonic Resonance. Impedance Scan Analysis Active Power Factor Corrected Single Phase Front End. Control Methods for Single Phase APFC. Three Phase APFC and Control Techniques. PFC based on Bilateral Single Phase and Three Phase Converter.

Unit-V:

Design and simulation of variable structure adaptive model following control.

Suggested reading:

1. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007.
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000
3. J. Arrillaga, "Power System Quality Assessment", John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,"Power system Harmonic Analysis", Wiley, 1997.

Course Code	Course Title	L	T	P	C
MPED-503	DYNAMICS OF ELECTRICAL MACHINES	3	1	0	4

Course Ooutcomes:

Students will be able to:

1. Learn Performance characteristics of machine.
2. To understand the dynamics of the machine.
3. To understand how to determine stability of machine.
4. Learn the synchronous machine analysis.

Syllabus:

Units-I:

Stability. Primitive 4 Winding Commutator Machine. Commutator Primitive Machine. Complete Voltage Equation of Primitive 4 Winding Commutator Machine.

Unit-II:

Torque Equation. Analysis of Simple DC Machines using the Primitive Machine Equations. The Three Phase Induction Motor. Transformed Equations. Different Reference Frames for Induction Motor Analysis Transfer Function Formulation.

Unit-III:

Three Phase Salient Pole Synchronous Machine. Parks Transformation- Steady State Analysis.

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Unit-IV:

Large Signal Transient. Small Oscillation Equations in State Variable form. Dynamical Analysis of Interconnected Machines.

Unit-V:
Large Signal Transient Analysis using Transformed Equations. DC Generator /DC Motor System.

Suggested reading:
1. D.P. Sengupta & J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd. 1980.
2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001. 3. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company, 1987
4. I. Boldia & S.A. Nasar,,"Electrical Machine Dynamics", The Macmillan Press Ltd. 1992
5. C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967

Discipline Elective-2: MPED-504

Course Code	Course Title	L	T	P	C
MPED-504	STATIC VAR CONTROLLER AND HARMONIC FILTERING	3	1	0	4

Course Obutcomes:
Students will be able to:
1. Understand the various static converters
2. Understand the static converter control strategies
3. Understand the active and reactive power compensation and their control
4. Understand harmonic filtering and its control design.

Syllabus
Unit-I:
Fundamentals of Load Compensation. Steady-State Reactive Power Control in Electric Transmission Systems. Reactive Power Compensation and Dynamic Performance of Transmission Systems.

Unit-II:
Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion. Current Harmonics. Sources of Harmonics in Distribution Systems and ill effects.

Unit-III:
Static Reactive Power Compensators and their control. Shunt Compensators. SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control. Series Compensators of thyristor Switched and Controlled Type and their Control. SSSC and its Control, Sub-Synchronous Resonance and damping.

Unit-IV:
Converters for Static Compensation. Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM). GTO Inverters. Multi-Pulse Converters and Interface Magnetics. Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM). Multi-level inverters of Cascade

Unit-V:
Passive Harmonic Filtering. Single Phase Shunt Current Injection Type Filter and its Control. Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modeling. Three phase four wire shunt active filters. Hybrid Filtering using Shunt Active Filters. Dynamic Voltage Restorer and its control. Power Quality Conditioner.

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Suggested reading

1. Ned Mohan et.al, "Power Electronics",John Wiley and Sons,2006.
2. G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc., 1988.
3. B. J. Baliga," Power Semiconductor Devices",Thomson, 2004

tical modeling skills needed for modeling and analysis of such Static VAR

Course Code	Course Title	L	T	P	C
MPED-504	PWM CONVERTERS AND APPLICATION	3	1	0	4

Course Outcomes:

Students will be able to:

1. Understand the concepts and basic operation of PWM converters, including basic circuit operation and design.
2. Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

Syllabus

Unit-I:

AC/DC and DC/AC power conversion. Overview of applications of voltage source converters and current source converters.

Unit-II:

Pulse width modulation techniques for bridge converters, Bus clamping PWM. Space vector based PWM. Advanced PWM techniques.

Unit-III:

Practical devices in converter. Calculation of switching and conduction power losses.

Unit-IV:

Compensation for dead time and DC voltage regulation. Dynamic model of PWM converter. Multilevel converters. Constant V/F induction motor drives.

Unit-V:

Active power filtering. Reactive power compensation. Harmonic current compensation. Selective harmonic elimination PWM technique for high power electric drives.

Suggested reading:

1. Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John's Wiley and Sons.
2. Erickson RW, "Fundamentals of Power Electronics", Chapman and Hall.
3. Vithyathil. J, "Power Electronics: Principles and Applications", McGraw Hill.

Course Code	Course Title	L	T	P	C
MPED-504	ADVANCED DIGITAL SIGNAL PROCESSING	3	1	0	4

Course Outcomes:

Students will be able to:

1. Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems
2. Study the design techniques for IIR and FIR filters and their realization structures.
3. Acquire knowledge about the finite word length effects in implementation of digital filters.
4. Knowledge about the various linear signal models and estimation of power spectrum of stationary

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randomsignals.
5. Design of optimum FIR and IIR filters

Syllabus:

Unit I:

Discrete time signals, Linear shift invariant systems- Stability and causality, Sampling of continuous time signals-Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier Transform, Z transform-Properties of different transforms.

Unit II:

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method.

Unit III:

FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantization effects in IIR and FIR filters.

Unit IV:

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zeroInput limit cycles in IIR filters, Linear Signal Models.

Unit V:

Optimum linear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIR Filters.

Suggested reading:

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Grow-Hill Edition 1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions .-2000

Discipline Elective-3: MPED-521

Course Code	Course Title	L	T	P	C
MPED-521	ADVANCED MICRO-CONTROLLER BASED SYSTEMS	3	1	0	4

Course Outcomes:

Students will be able to:
1. To learn how to program a processor in assembly language and develop an advanced processor based system.
2. To learn configuring and using different peripherals in a digital system.
3. To compile and debug a Program.
4. To generate an executable file and use it.

Syllabus:

Unit I:

Basic Computer Organization. Accumulator based processes-Architecture-Memory. Organization-I/O Organization.

Unit II:

Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories. I/O Ports, Serial Communication. Timers, Interrupts, Programming.

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Unit III:
Intel 8051 – Assembly language programming-Addressing-Operations- Stack & Subroutines, Interrupts-DMA.

Unit IV:
PIC 16F877- Architecture Programming. Interfacing Memory/ I/O Devices, Serial I/O and data communication.

Unit V:
Digital Signal Processor (DSP) - Architecture – Programming, Introduction to FPGA.

Unit VI:
Microcontroller development for motor control applications. Stepper motor control using micro controller.

Suggested reading:

1. John.F.Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons 1981.
2. Ramesh S.Gaonker: "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing (India), 1994.
3. Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005.
4. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004.
5. John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005.
6. Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008.
7. Microchip datasheets for PIC16F877.

Course Code	Course Title	L	T	P	C
MPED-521	DISTRIBUTED GENERATION	3	1	0	4

Course Outcomes:
Students will be able to:
1. To understand renewable energy sources.
2. To gain understanding of the working of off-grid and grid-connected renewable energy generation schemes.

Syllabus:
Unit I:
Need for Distributed generation. Renewable sources in distributed generation and current scenario in Distributed Generation.

Unit II:
Planning of DGs. Sitting and sizing of DGs optimal placement of DG sources in distribution systems. Grid integration of DGs Different types of interfaces, Inverter based DGs and rotating machine based interfaces. Aggregation of multiple DG units.

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Faculty of Engineering & Technology
DEAN

Unit III:
Technical impacts of DGs. Transmission systems Distribution Systems De-regulation Impact of DGs upon protective relaying. Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis.

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Unit IV:
Economic and control aspects of DGs Market facts. Issues and challenges Limitations of DGs Voltage control techniques. Reactive power control

Harmonics Power quality issues, Reliability of DG based systems.

Unit V:
Introduction to micro-grids. Types of micro-grids: autonomous and non-autonomous grids Sizing of micro-grids. Modeling & analysis of Micro-grids with multiple DGs. Micro-grids with power electronic interfacing units.

Unit VI:
Transients in micro-grids, Protection of micro-grids, Case studies, Advanced topics.

Suggested reading:

1. H. Lee Willis, Walter G. Scott, "Distributed Power Generation – Planning and Evaluation",
Marcel Decker Press.
2. M.GodoySimoes, Felix A.Farret, "Renewable Energy Systems – Design and Analysis with
Induction Generators", CRC press.
3. Stuart Borlase. "Smart Grid: Infrastructure Technology Solutions" CRC Press.

Course Code	Course Title	L	T	P	C
MPED-521	SMART GRIDS	3	1	0	4

Course Outcomes:
Students will be able to:
1. Understand concept of smart grid and its advantages over conventional grid.
2. Know smart metering techniques.
3. Learn wide area measurement techniques.
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

Syllabus:
Unit I:
Introduction to Smart Grid, Evolution of Electric Grid. Concept of Smart Grid, Definitions, Need of Smart Grid. Concept of Robust &Self-Healing Grid, Present development & International policies in Smart Grid.

Unit II:
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, Smart Substations, Substation Automation, Feeder Automation.

Unit III:
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).

Unit IV:
Concept of micro-grid, need & applications of micro-grid. Formation of micro-grid, Issues of interconnection. Protection & control of micro-grid. Plastic & Organic solar cells, Thin film solar cells. Variable speed wind generators, fuel-cells, micro-turbines. Captive power plants, Integration of renewable energy sources.

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Unit V:
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, Power Quality Audit.

Unit VI:
Advanced Metering Infrastructure (AMI), Home Area Network (HAN). Neighbourhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication. Wireless Mesh Network.Basics of CLOUD Computing &Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

Suggested reading

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC
Press, 2009.

Suggested reading:

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 2011.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press, 2009.
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications", Wiley 2012.
4. Stuart Borlas'e, "Smart Grid:Infrastructure, Technology and solutions "CRC Press.
5. A.G.Phadke , "Synchronized Phasor Measurement and their Applications",Springer.

Course Code	Course Title	L	T	P	C
MPED-521	SCADA SYSTEM AND APPLICATIONS	3	1	0	4

Course Outcomes:
1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their
Typical applications.
2. Acquire knowledge about SCADA architecture, various advantages and disadvantages of
Each system.
3. Knowledge about single unified standard architecture IEC 61850.
4. To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic
devices, HMI systems, SCADA server.
5. Learn and understand about SCADA applications in transmission and distribution sector,
industries etc.

Syllabus:
Unit I:
Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies.

Unit II:
Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA.

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Unit III:
Industries SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network. SCADA Server. SCADA/HMI Systems.

Unit IV:
SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture –IEC 61850.

Unit V:
SCADA Communication: various industrial communication technologies-wired and wireless methods and fiber optics. Open standard communication protocols.

Unit VI:
SCADA Applications: Utility applications- Transmission and Distribution sector operations, monitoring, analysis and improvement. Industries - oil, gas. Case studies, Implementation, Simulation Exercises.

Suggested reading:

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of
America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and
Related Systems", Newnes Publications, Oxford, UK,2004.
3. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
5. Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric
power",PennWell 1999.

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OPEN ELECTIVE

MPED-541 INDUSTRIAL OPTIMIZATION TECHNIQUES

(L-2, T-0,P-0; CREDITS:2)

Course Outcomes:

At the end of this course, the students will be able to:

CO -1: Remember the concept of simultaneous equations; apply for evaluating mathematical programming problems to evaluate optimal solution K1, K3& K5

CO-2: Understand the concept of extrema to create, critical path and analyzing for application in Engineering. K2, K3 & K6

CO -3: Remember the concept of matrices, maxima and minimize to evaluate the value of the game and create the model K1, K5&K6

CO-4: Analyze the concept of simulation in different ways by simulation techniques methods. K4& K3

CO-5: Applying the concept of extrema to evaluate inventory and replenishment problems K3& K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

SYLLABUS:

UNIT I: Linear Programming, Transportation and Assignment Models

Introduction to optimization and engineering applications, formulation of linear programming problems, graphical, simplex and dual simplex methods, transportation and assignment models, Hungarian method, travelling salesman problem, and engineering applications.

UNIT II: Sequencing and Network Analysis

Sequencing problems for two and multiple machines, Johnson's algorithm, network analysis, CPM and PERT techniques, network construction, time estimation, forward and backward pass computations, and engineering applications.

UNIT III: Game Theory and Queuing Models

Game theory concepts, two-person zero-sum games, maximin and minimax principles, saddle point, dominance principle, graphical solutions, queuing theory, Poisson queuing models, single-server and multi-server systems, and engineering applications.

UNIT IV: Dynamic Programming and Simulation

Principles of dynamic programming, formulation and solution techniques, forward recursion, capital budgeting, cargo loading, solution of linear programming problems using dynamic programming, simulation concepts, Monte Carlo simulation, and engineering applications.

UNIT V: Inventory Control and Replacement Models

Inventory management concepts, inventory costs, deterministic and probabilistic inventory models, replacement policies for deteriorating and failed items, equipment replacement, individual and group replacement strategies, and engineering applications.

Text Books:

1. Singiresu S. Rao. "Engineering Optimization" Theory and Practice". New Age International, New Delhi.

2. R. Panneerselvam. "Operations Research ". Prentice- Hall of India, New Delhi

Reference Books:

1. H.A. Taha: Operations Research – An Introduction, Macmillan Publishing Company, Inc., New York.

2. S.S. Rao: "Optimization Theory and Applications", Wiley Eastern Ltd., New Delhi.

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