Scheme of Teaching & Examination
M.Tech in Power Electronics
I - Semester

S.N.	code	Subject	Periods per week			Scheme of marks		Total Credit
			L	T	P	ESE	IM	
1.	MTECE130	Power Converters	4	-	-	70	30	4
2.	MTECE131	Microcontroller & Embedded System	4	-	-	70	30	4
3.	MTECE132	Power Electronic Circuits	4	-	-	70	30	4
4.	MTECE133	Industrial Control Electronics	4	-	-	70	30	4
5.	Ref Table	ELECTIVE - I	4	-	-	70	30	4
6.	MTECE135	Power Converters Lab	1	-	2	30	20	2
7.	MTECE136	Microcontroller & Embedded System Lab	1	-	2	30	20	2
8.	MTECE137	Power Electronic Circuits Lab	1	-	2	30	20	2
Total			**23**	**0**	**6**	**440**	**210**	**26**

Elective – I

S.No	Subject code	Name of Subject
1.	MTECE1340	Advance Control Theory
2.	MTECE1341	Power Systems Operation And Control
3.	MTECE1342	Energy Auditing, Conservation & Management
4.	MTECE1343	Advanced Power System Protection
5.	MTECE1344	Transient Over Voltages In Power Systems

L – Lecture, T – Tutorial, ESE – End Semester Examination,
P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Power Converters	Total Theory Periods :	40
		Code :	MTECE130

UNIT : I

Analysis of switched circuits- thyristor controlled half wave rectifier – R, L, RL, RC load circuits, classification and analysis of commutation.

UNIT :II

Single-Phase and Three-Phase AC to DC converters- half controlled configurations operating domains of three phase full converters and semi-converters – Reactive power considerations.

UNIT :III

Analysis and design of DC to DC converters- Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converters, Cuk converters

UNIT :IV

Single phase and Three phase inverters, Voltage source and Current source inverters, Voltage control and harmonic minimization in inverters.

UNIT :V

AC to AC power conversion using voltage regulators, choppers and cyclo-converters, consideration of harmonics.

TEXT BOOKS:

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design”, John Wiley and sons.Inc, Newyork,3rd edition 2002.
2. Rashid M.H., „Power Electronics Circuits, Devices and Applications „, Prentice Hall India, New Delhi, 3rd edition 2004.
3. P.C Sen.,“ Modern Power Electronics „, Wheeler publishing Co, First Edition, New Delhi, 1998.

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Microcontroller & Embedded System	Total Theory Periods :	40

Code : MTECE131

UNIT – I

Architecture 16 bit microprocessors: Intel 8086 Architecture- Memory address space and data organization - Segment registers and memory segmentation - I/O address space - Addressing modes - Comparison of 8086 and 8088 - Basic 8086/8088 configuration - Minimum mode - Maximum mode - System timing. Bus interface. Interrupts and interrupt priority management. Intel 80286 Architecture- Comparison with 8086 processor. Architecture of 32 bit Microprocessors: Intel 80386 Architecture

UNIT – II

Introduction to Microcontroller, brief History of 8051, 8052, 8031, 8751, AT89651, Pin configuration of 8051, 89C52RD2, Instruction set of 8051, Assembly language programming , Internal structure of 8051 , Power resetting , Built up RAM & ROM, I/O programming and Addressing modes.

UNIT – III

Introduction to counter and timer, Counter and timer programming using 8051, interrupt programming, Types of interrupt.

UNIT – IV

Introduction to Asynchronous serial communication, Data programming, RS232 standard, RS422 Standard, 1488 & 1489 standard, GPIB, Max 232 Driver, Serial communication programming.

UNIT – V

Introduction to Embedded Systems, Definition of Embedded System, Embedded Systems v/s General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems, embedded design concept.

TEXT BOOKS:

1. Barry B. Brey , The Intel Microprocessors 8086 to Pentium 4 - Architecture Programming and Interfacing, 6/e Pearson Education ,2003.
2. James L. Antonacos , An Introduction to Intel Family of Microprocessors , 3/e Pearson Education, 2002.

REFERENCE BOOKS:

1. John Uffenbeck , The 80x86 Family Design Programming and Interfacing, 3/e Pearson Education, 2002.
2. YU-Cheng Liu & Glenn A Gibson, Microprocessor System , Architecture Programming & Design, Pentice Hall of India.
3. Douglas V Hall, Microprocessors & Interfacing, Tata McGrawhill, 1998.
4. The 8051 Microcontroller and Embedded Systems using Assembly and C, Mazidi, Mazidi & McKinlay, 2nd Ed.,PHI.

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Power Electronic Circuits	Total Theory Periods :	40
	Code :	MTECE132	

UNIT – I

Ideal and Real switches, static and dynamic performance, Power diodes, Power Transistors,Power MOSFETS, IGBTs, Thyristor, GTO, TRIAC- Static and Dynamic Performance, Driver circuits. Turn on, Turn off and Over voltage Snubbers for switching devices.

UNIT – II

Uncontrolled rectifiers-Single phase and Three phase- Analysis with R and RL loads, effect ofsource inductance-Effect of Single Phase Rectifiers on Neutral Currents in a Three Phase Four-Wire System.

Controlled Rectifiers-Single phase and Three phase-fully controlled and semicontrolled- Analysis with RL, RLE loads-Performance, Inversion mode of operation- Effect ofsource inductance-Dual converters- Circulating and Non circulating type.

UNIT – III

Chopper - Principle of operation, two quadrant and four quadrant choppers, PWM control-Forced commutation- Voltage and Current commutated choppers, multiphase chopper.

UNIT – IV

Inverter - Half Bridge and Full Bridge- Six Step and Two Level PWM. Harmonics andVoltage control in inverters- Current source inverter-Single phase and Three phase. Introductionto Multilevel Invertors-Different types

UNIT – V

AC Voltage Controllers- Single Phase and Three phase, Principle of operation-analysis with R and RL loads, Thyristor Controlled Inductor

Cyclo converters- types- Single Phase and Three phase- Circulating and Non circulatingtype, Analysis with R and RL loads.

TEXT BOOKS:

1. Ned Mohan, Undeland, Robbins, Power Electronics; Converters, Applications and Design-3rd edn, John Wiley, 2003.
2. M H Rashid; Power Electronics Circuits, Devices and Applications, Pearson.

REFERENCE BOOKS:

1. William Shepherd, Li Zhang., Power Converter Circuits, Marcel Dekker, 200.4
2. Joseph Vithayathil, Power Electronics; Principles and Applications, McGrawHill-1994
3. Philip T Krein, Elements of Power Electronics- Oxford, 1998
4. IssaBatarseh, Power Electronics Circuits, John Wiley, 2004

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Industrial Control Electronics	Total Theory Periods :	40

Code : MTECE133

UNIT – I
Review of switching regulators and switch mode power supplies-Uninterrupted power supplies-solid state circuit breakers – programmable logic controllers

UNIT – II
Analog Controllers - Proportional controllers, Proportional – Integral controllers, PID controllers, Feed forward control

UNIT – III
Signal conditioners-Instrumentation amplifiers – voltage to current, current to voltage, voltage to frequency, frequency to voltage converters ; Isolation circuits – cabling; magnetic and electro static shielding and grounding.

UNIT – IV
Opto-Electronic devices and control , Applications of opto isolation, interrupter modules and photo sensors – Fibre optics – Bar code equipment, application of barcode in industry.

UNIT – V
Stepper motors and servo motors- control and applications. Servo motors – servo motor controllers – servo amplifiers – selection of servo motor – applications of servo motors.

TEXT BOOKS:
1. Michael Jacob, „Industrial Control Electronics – Applications and Design‟, Prentice Hall, 1988.
2. Thomas, E. Kissel, „ Industrial Electronics‟PHI, 2003
3. James Maas, „Industrial Electronics‟, Prentice Hall, 1995.

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Advance Control Theory	Total Theory Periods :	40
	Code :	MTECE1340	

UNIT – I

Introduction-Concept of State-State equation for Dynamic Systems-Time invariance and linearity-Non uniqueness of state model-State Diagrams-Physical System and State Assignment.

UNIT – II

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential System modes, Role of Eigen values and Eigenvectors.

UNIT – III

Controllability and Observability- Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT – IV

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

UNIT – V

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems- The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TEXT BOOKS:

1. M. Gopal, “Modern Control System Theory”, New Age International, 2005.
2. K. Ogatta, “Modern Control Engineering”, PHI, 2002.

REFERENCE BOOKS:

1. John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill, 1999.
2. D. Roy Choudhury, “Modern Control Systems”, New Age International, 2005.
3. John J. D‟Azzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, 2003.
4. Z. Bubnicki, ”Modern Control Theory”, Springer, 2005.

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Power Systems Operation And Control	Total Theory Periods :	40

Code : MTECE1341

Unit-I

Optimal Generation Scheduling: Power flow scheduling using economic load dispatch, power flow scheduling using Lagrange multiplier method, penalty factor, scheduling with network losses, hydrothermal coordination with and without losses, cascaded and pump storage plant scheduling, unit commitment, unit commitment solution methods, introduction to optimal power flow solution using Newton Raphson method.

Unit-II

Automatic Generation Control: Types of alternator exciters, automatic voltage regulators for generator excitation control, static and dynamic performance of AVR loop, automatic load frequency control, primary automatic load frequency control loop, secondary automatic load frequency control loop, extension of automatic load frequency control loop to multi area systems, tie line power flow model.

Unit-III

Power System Security: Security analysis, security assessment, contingency analysis, algorithm to determine system security following contingency analysis procedure, security assessment using ac power flow model, security analysis using concept of performance index.

Unit-IV

State Estimation and load forecasting: Methods of state estimation – least square and weighted least square estimation, bad data detection and suppression of bad data, load forecasting, load forecasting techniques – methods of extrapolation and correlation, estimation of average and trend terms of deterministic part of load – limitation of the method, prediction of deterministic load, generalized load modeling, estimation of periodic components, estimation of stochastic part of load – time series approach.

Books:

1. Power System Analysis, Operation and Control, Abhijit Chakrabarti and Sunita Halder PHI.

2. Power Generation Operation and Control, Allen J. Wood, Bruce F. Woolenburg

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Energy Auditing, Conservation & Management	Total Theory Periods :	40

Code : MTECE1342

Unit-I

Introduction: Energy Scenario – global, sub continental and Indian, Energy economy relation, Future energy demand and supply scenario, Integrated energy planning with particular reference to Industrial Sector in India, Captive power units and others –demand v/s supply.

Unit-II

Types of Energy: Physical Aspects of Energy: Classification of energy – Hydel, Thermal, Nuclear, Wind, & from Waste Products. Efficiency and effectiveness of energy utilization in Industry. Energy and energy analysis. Renewable and nonrenewable energy, Conventional and unconventional energy. **Demand Side Management:** Energy Demand Management: Energy utilization, Instrumentation and data analysis, Financial aspects of energy management, Energy management as a separate function and its place in plant management hierarchy. Energy Planning, Energy Staffing, Energy Organization, Energy equirement. Energy Costing, Energy Budgeting, Energy Monitoring, Energy Consciousness, Energy Conversions, Energy Efficient Equipment, Energy Management Professionals, Environment Pollution due to Energy Use, Components of Pollution, Harmful Effects of Pollution, Measures taken to combat Pollution.

Unit-III

Energy Audit and Energy Saving: Energy Audit and analysis, Energy load measurements, System evaluation and simulation, Energy saving techniques and guidelines: Administrative control, Proper Measurement and monitoring system, Process control, proper planning & scheduling, Increasing capacity utilization, Improving equipment control, waste heat recovery, Change of energy source. Upgradation of Technology. Change of product specifications, Use of High efficiency equipment, Design modification for better efficiency, Improved periodic maintenance;

Unit-IV

Energy Control Centers: Remote Telemetry; Remote Terminal Units; IEC TC 57 (870-5-1) Protocol Standard; Data Acquisition Procedure; Data Handling and Organization; Real Time Database; Alarm and Events; Disturbance Processing; Fault Locating Technology; Real Time Display; MIMIC Boards; Supervisory Remote Control; Load Dispatch Control Centers; Distribution Control Centers; Time Keeping Systems;

Unit-V Integration of Distributed and Renewable Energy Systems to Power Grids: DC-to-AC Converters; AC-to-AC Converters; DC-to-DC Converters; Plug-In Hybrid Electric Vehicles; Energy Storage Technologies; Microgrids; **Legal Provisions:** The Prevention and Control of Pollution Act, 1974, The Energy Conservation Act, 2001, The Environmental Protection Act, 1986. The Electricity Act, 2003. National Electricity Policy. Rural Electrification.

Reference Books:

1. Paul W., O'callaghan; "*Energy Management*", McGraw Hill Book Company
2. Steve Doty, Wayne C. Turner; "*Energy Management Handbook*", Fairmont Press Inc., GA 30047
3. Barny L. Capehart, Wainey C. Turner, William J. Kennedy; "*Guide to Energy Management*", Fairmont Press Inc., GA 30047
4. Handbook of Energy Engineering, Albert Thumann & Paul Mehta, The Fairmont Press, INC.
5. NPC energy audit manual and reports
6. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Advanced Power System Protection	Total Theory Periods :	40

Code : MTECE1343

Unit-I Introduction: Protective Relays; Basic requirements and type of protection, reviews of relay characteristics and operating equations, protective CTs, PTs, , phase and amplitude comparator, classification of Electromagnetic relays, Plug Setting Multiplier and Time Multiplier setting, Universal Torque Equation, Non Directional Relay, Directional relay, Distant relay, Differential relay.

Unit-II 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.

Protection of Transformer: Overcurrent and unrestricted Earth fault protection, Different CT connections, Balanced (Restricted) earth fault protection, Harmonic restraint, Frame leakage protection

Unit-III Bus bar, Feeder, Transmission line Protection:

Bus bar Protection: Circulating Current Protection, Frame Leakage Protection. 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. Pilot Relaying Schemes: Wire Pilot Protection, Carrier Current Protection.

Unit-IV Static Relay

Introduction: Basic construction of static relays, advantages and disadvantages of Static Relay, different types of static relays (static overcurrent, static time overcurrent, static instantaneous overcurrent, directional static overcurrent, static differential and static distance relay) comparators and associated elements, system switching and transient effects.

Unit-V Protection of High Voltage Capacitor Bank: Including consideration of inrush current, over current and over voltage, and differential protection scheme.

Protection Of large Motors: Differential protection, Earth fault Protection, Thermal overload protection, Starting and Stalling currents and effect of negative Sequence current.

Digital Relay: Introduction, protection philosophy, basic hardware and protection schemes, protection algorithms, microprocessor based digital relaying.

Text Books:

1. A. Chakrabarti,M.L. Soni, P. V. Gupta, U. S. Bhatnagar “A text book on Power System Engineering”, Dhanpat Rai and Co.
2. Paithankar.Y.G and Bhide.S.R, “Fundamentals of Power System Protection”, Prentice-Hall of India.
3. Badri Ram and Vishwakarma.D.N, “Power System Protection and Switchgear”, Tata McGraw- Hill Publishing Company, 2002.
4. Arun K. Phadke, James. S. Thorp, “Computer relaying for Power system”, John Wiley and sons, New York, 1998.

Reference:

1. Power System Protection, PM Anderson, IEEE Press Book
2. Protective Relays Application and Guide, GEC Measurements
3. Jones D., “ Analysis and protection of electrical power systems”, Pitman Publishing, 1971

MATS UNIVERSITY

Semester :	1st M.Tech. Course	Branch :	Power Electronics
Subject :	Transient Over Voltages In Power Systems	Total Theory Periods :	40
		Code :	MTECE1344

Unit-I

Introduction and survey: Review of various types of power system transients – effect of transients on power systems –relevance of the study and computation of power system transients.

Unit-II

Lighting surges: Electrification of thunderclouds – lightning current surges – lightning current parameters and their values – stroke to tower and midspan – induced lightning surges.

Unit-III

Switching surges: Closing and reclosing of lines – load rejection – fault initiation – fault clearing – short line faults – Ferro – resonance – isolator switching surges – temporary over voltages – surge on an integrated system – switching – harmonics.

Unit-IV

Computation of transient in conversion equipment: Travelling wave method – Beweley's Lattice diagram – analysis in time and frequency domain – eigen value approach – Z-transform – EMTP software.

Unit-V

Insulation coordination: Over voltage protective devices – shielding wires, rods gaps and surge diverters, principles of insulation co ordination-recent advancements in insulation co ordination – design of EHV system.

References:

1. Allan Greenwood, Electrical transients in Power Systems, Wiley Interscience, New York, 1971.
2. Klaus Ragaller, Surges in High Voltage Networks, Plenum Press, New York, 1980.
3. Diesendrof W., Over Voltages On High Voltage Systems, Renselaer Bookstore, Troy New York, 1971.
4. Peterson H.A., transients in power systems, Dover Publications, New York, 1963.

MATS UNIVERSITY

Semester : 1st M.Tech. Course Branch : Power Electronics
Subject : Power Converters Lab

Code : MTECE135

Experiments and computer simulations on:

1. Single phase, three phase Semi converters and Full converters,

2. DC-DC Choppers using SCRs and Self communicating Devices.

3. Single phase and three phase inverters using IGBTs,

4. AC-AC voltage regulators.

5. DC and AC drives

MATS UNIVERSITY

Semester : 1st M.Tech. Course Branch : Power Electronics
Subject : Microcontroller & Embedded System Lab

Code : MTECE136

List of Experiments:

1. Write a microcontroller 8051 program to transfer the bytes into RAM locations starting at 50H, assuming that ROM space starting at 240H contains CHHATTISGARH by using –
a) a Counter,
b) null char for end of string.

2. Write a microcontroller 8051 program to get hex data on the range of 00-FFh from port 0 and convert it to decimal. Save the digits in R7, R6 and R5, where the LSB is in R7.

3. Write a microcontroller 8051 program to add two 16 Bit unsigned numbers. Operands are two RAM variables. Results to be in R1-R0 pair.

4. Write a microcontroller 8051 program to subtract an unsigned 16 Bit number from another. Operands are two RAM variables. Results to be in R1-R0 pair.

5. Write a microcontroller 8051 program to add two unsigned 32-bit numbers. Operands are two RAM variables. Results to be in R1-R0 pair.

6. Write a microcontroller 8051 program to add two 16 Bit signed numbers.

7. Write a microcontroller 8051 program to convert a binary number to equivalent BCD

8. Write a microcontroller 8051 program to convert a packed BCD number to two ASCII numbers and place them in R5 and R6.

9. Write a microcontroller 8051 program to calculate the square root of an 8-bit number using iterative method.
10. Write a microcontroller 8051 program to add two floating-point numbers.

11. Write a microcontroller 8051 program to multiply two floating-point numbers.

12. Write a microcontroller 8051 program that generates 2kHz square wave on pin P1.0, 2.5 kHz on pin P1.2 and 25 Hz on pin P1.3.

List of Equipments/Machine Required:
Microcontroller kit, Interfacing kit, Keyboard, Monitor, SMPS for Microcontroller

MATS UNIVERSITY

Semester : 1st M.Tech. Course Branch : Power Electronics
Subject : Power Electronic Circuits Lab

Code : MTECE137

List of Experiments: A) HARDWARE

1. Single Phase Semi-converter with R-L load for continuous & discontinuous conduction modes.

2. Single Phase Full-converter with R-L load for continuous & discontinuous conduction modes.

3. Three Phase Full-converter with R-L-E load.

4. Controlled and Uncontrolled rectifier with different types of filters - continuous & discontinuous modes of operation.

5. Transformer and Inductor design.

6. Current & voltage commutated thyristorized chopper.

7. MOSFET/ IGBT/Transistor based DC Choppers (Buck & Boost)

8. Half bridge square wave inverter

9. Single-phase Sine triangle PWM inverter

10. Single Phase AC Voltage Controller

B) SIMULATION

1. 3-phase full converter and semi-converter with R, RL and RLE loads

2. 3-phase ac voltage controller

3. Closed loop control of DC-DC converter

4. 3-phase sine PWM inverter

5. Measurement of THD of current & voltage waveforms of controlled & uncontrolled 3- phase rectifiers.