Shri Rawatpura Sarkar University, Raipur

Scheme of Teaching, Examination and Syllabus

for

M.Tech. (Power Electronics)

Semester-I

(Effective from the session: 2022-23)

SHRI RAWATPURA SARKAR UNIVERSITY, RAIPUR, CHHATTISGARH
FACULTY OF ENGINEERING

Two Years M.Tech. Programme

Scheme of Teaching and Examination

M.Tech. First Semester Power Electronics

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2022-2023)

S.No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1	MENPE101T	Power Converter	3	1	-	4	30	70	100	3
2	MENPE101P	Power Converter	-	-	2	1	15	35	50	-
3	MENPE102T	Industrial Control Electronics	3	1	-	4	30	70	100	3
4	MENPE103T	Microcontroller & Embedded System Design	3	1	-	4	30	70	100	3
5	MENPE103P	Microcontroller & Embedded System Design	-	-	2	1	15	35	50	-
6	MENPE104T	Modern Control Theory	3	1	-	4	30	70	100	3
7	MENPE105T	Elective -I	3	1	-	4	30	70	100	3
						22			600	

L-Lecture T-Tutorial P-Practical

Elective-I

(A) Analysis & Design of Artificial Neural Network
(B) Modelling & Analysis of Electrical Machines
(C) Digital Controllers in Power Electronics Application

<table>
<tr><td>Course Title</td><td colspan="5">Power Converter</td></tr>
<tr><td>Course Code</td><td colspan="5">MSCCP101T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Working of Power Electronics devices</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students to:
To understand the working of various types of converters.
To learn how to analyze the converters and design the components of them, under various load types
Analyze current and voltage waveforms in a converter</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT – I
Analysis of Switching circuit
Analysis of switched circuits- thyristor controlled half wave rectifier – R, L, RL, RC load circuits, classification and analysis of commutation.
UNIT - II
Three Phase AC to DC converters
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
DC to DC converters
Analysis and design of DC-to-DC converters- Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converters, Cuk converters
UNIT - IV
Inverter
Single phase and Three phase inverters, Voltage source and Current source inverters, Voltage control and harmonic minimization in inverters</td></tr>
</table>

	UNIT - V **AC regulator and Cyclo-converter** AC to AC power conversion using voltage regulators, choppers and cyclo-converters, consideration of harmonics.
Course Outcomes	**At the end of this subject student is able to:** • Formulate and analyze a power electronic design at the system level and assess the performance. • Design and Analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields. • ability to use techniques, skills and modern engineering tools necessary for engineering practice
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. Numerical Methods, S Chand and Co. Ltd, Kandasamy.P ,Thilagavathy. K and Gunavathy, K - New Delhi, 5th Edition, 2007
Reference Books:	1. B.K. Bose, 'Modern Power Electronics & AC drives', Prentice Hall 2. Phillip T Krein, 'Element of power Electronics', Oxford, 2007 3. J.P. Agarwal, 'Power Electronics systems', Pearson 4. M.S. Jamal Asghar, 'Power Electronics', PHI, 2007 5. J.M. Jacob, 'Power Electronics: Principles and applications', Thomson

Course Title	**Industrial Control Electronics**				
Course Code	**MENPE102T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Basics of Electronics, controller**				
Course objectives	**This course will enable students-** • To learn about latest electronic devices available in industry • To learn about signal conditioning and its process • To demonstrate an understanding of photoelectronic, lasers, and fiber optics • To learn about Stepper motors and servomotors, their control and applications				
Course Contents	**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.
Course outcomes	**At the end of this course students will be able to-** • Apply critical thinking in solving industrial electronic problems. • Having a clear understanding of the subject related concepts and their applications in industries. • Use their knowledge and technical skill in process control and automation industry.
Text Books	1. Michael Jacob, 'Industrial Control Electronics – Applications and Design', Prentice Hall, 1988. 2. Thomas E. Kissell, Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, 3rd edition, 2003, Prentice Hall 3. James Maas, 'Industrial Electronics', Prentice Hall, 1995.
Reference Books	1. Dale Patrick, Stephen Fardo, "Industrial Process Control system". 2. Smith C.A. & A.B. Corripio," Principal & Practiced Automatic Process Control", J. Wiley. 3. Shinskey F.G." Process control System", III Ed. McGraw Hill 2. Rao M &S. Qiv," Process Control Engg." Gordan& Breach

<table>
<tr><td>Course Title</td><td colspan="5">Microcontroller & Embedded System Design</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE103T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Digital Electronics</td></tr>
<tr><td>Course objectives</td><td colspan="5">This course will enable students-
The objective of this course is to provide knowledge about the Embedded system their evolution, hardware architecture and development process.
To get knowledge of microcontroller 805, its architecture and interfacing with various integrated circuits.
The aim of this course is to give the knowledge of various instructions, basic programming with Microprocessors 8085, data transfer schemes, Instruction format and addressing modes.
Tofamiliar with PIC family Microchip, its working and interfacing.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT–I
Overview of Embedded System: - Embedded System, Categories of Embedded System, Requirements of Embedded Systems, Challenges and Issues in Embedded Software Development, Applications of Embedded Systems in Consumer Electronics, Control System, Biomedical Systems, Handheld computers, Communication devices.

UNIT-II
Embedded Hardware & Software Development Environment: - Hardware Architecture, MicroController Architecture, Communication Interface Standards, Embedded System Development Process, Embedded Operating systems, Types of Embedded Operating systems.</td></tr>
</table>

	UNIT-III 8 Bit microcontrollers Architecture on chip peripherals instruction set/programming of Intel MCS51 family (8 bit) microcontroller, Interfacing of 8051 with LCD, ADC, sensors, stepper motor, key board, DAC, Memory interfacing. **UNIT –IV** Real Time & Database Applications: - Real- Time Embedded Software Development, sending a Message over a Serial Link, Simulation of a Process Control System, Controlling an Appliance from the RTLinux System, Embedded Database Applications using examples like Salary Survey, Energy Meter Readings. **UNIT- V** Microchip PIC16 family PIC16F873 processor features architecture memory organization register file map I/O ports PORTA - PORTB PORTC Data EEPROM and flash program memory Asynchronous serial port SPI mode I2C mode.
Course outcomes	**At the end of this course student will be able to:** • Understand Architecture of Embedded system and its various aspects • Program the 8051 microcontroller and understand interfacing with different ICs • Understand the PIC microchip and their features and interfacing
Text Books	1. Programming for Embedded Systems- Dreamtech Software Team, Wiley Dreamtech 2. The 8051 microscontrollers, M A Mazidi&Mazidi, Pearson Education 3. Design with PIC micro-controllers: John B Peatman, Pearson Education
Reference Books	1. Programming and customizing the 8051 microcontroller, 1st Edition; by: Predko, Myke; McGraw Hill International. 2. Embedded system by Raj Kamal TMH

<table>
<tr><td>Course Title</td><td colspan="5">Modern Control Theory</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE104T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Control System.</td></tr>
<tr><td>Course objectives</td><td colspan="5">This course will enable students-
• To understand the continuous and discrete state-space modelling of physical systems and apply controllability and observability criteria
• To understand the concepts and techniques of linear and nonlinear control system analysis and synthesis
• To understand optimal control system and robust control system.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT– I
Non-Linear Control Systems
Fundamentals-common nonlinearities (saturation, dead-zone, on-off non-linearity, backlash, Hysteresis) and their describing functions. Describing function analysis of non-linear systems. Phase plane analysis, phase portraits-Singular points characterization-Analysis of non-linear systems using phase plane technique-Existence of limit cycles.

UNIT– II
Stability analysis using State Space Technique
Basics, Eigen values, Eigen Vector, canonical forms, Caylay-Hamilton theorem, Computation of state transition matrix, controllability and Observability (Time Variant Systems), Effect of Pole-Zero cancellation in Transfer Function, Stability improvement by state feedback, Necessary and sufficient condition for arbitrary pole placement, Pole placement design, Ackermann’s Formula for Pole Placement, design of full and reduced order state observers, design of Servo system, State Feedback with Integral control, Design of compensator.</td></tr>
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	UNIT– III **Lyapunov stability analysis** Introduction - basic concepts, Concept of stability-stability in the sense of Lyapunov-absolute stability, indirect method of Lyapunov and direct method of Lyapunov with four Stability theorems. Lyapunov Stability Analysis of Linear Systems, Lyapunov function, Construction of Lyapunov function for nonlinear systems - variable gradient method-Lure problem-Popov's stability criterion. **UNIT– IV** **Optimal Control Systems:** Introduction. static and dynamic optimization. Parameter Optimization and Optimal Control problems, Performance Index, Calculus of Variations: Euler-Language equation and transversality conditions, Lagrange multipiliers, Pontryagin's maximum principle; theory; Linear regulator problem, matrix Riccati equation and its solution, Kalman filter, linear quadratic gaussian regulator. **UNIT– V** **Robust Control** Introduction, definition of robust control, classification of robust control, elements of robust control theory, modeling, design objectives and specifications, additive and multiplicative perturbations, plantcontroller configuration. Modeling of Parametric Uncertain Systems, robust stability analysis, Boundary crossing theorem, Schur stability test, Hurwitz stability test, robustness under perturbations, small gain theorem, stability margins.
Course outcomes	**At the end of this course students will be able to-** • Analyze the system response. • Construct the linear model for the Nonlinear system • do stability analysis using state space technique • Estimate the controllability and Observability for the given time variant system. • Analyze system using Lyapunov Stability Analysis • Understand Optimal Control system and Robust control

Text Books	1. Control Systems Engineering:I.J.Nagrath and M. Gopal; New Age International Publishers, 4th Edn. 2. Digital Control and State Variable Methods: M. Gopal; Tata McGraw-Hill, Second edition. 3. Applied Nonlinear Control: Jean-Jacques E. Slotine&Weiping Li; Prentice-Hall., NJ, 1991 4. Robust control – The parametric approach: S P Bhattacharya, L H Keel, H Chapellat; PrenticeHall, 1995
Reference Books	1. Modern Control Engineering: Roy Choudhary; PHI. 2. Modern Control Engineering: K. Ogata; PHI, second edition 1991. 3. Control Engineering Theory and Practice: M.N. Bandhopadhyay; PHI 4. Digital Control Systems:Benjamin.C. Kuo; Oxford University Press, Second edition

Course Title	**Power Converters Lab**				
Course Code	**MENPE101P**				
Course Credits	**L**	**T**	**P**	**TC**	
	-	**-**	**2**	**1**	
Prerequisites	**Power Electronics Device Terminal and Their Connections**				
Course objectives	**This course will enable students-** • To the objective of this course is to make students to learn principlesand design of Power converter • Toanalyze output waveform of various power electronic devices.				
Course Contents	**LIST OF EXPERIMENTS** List of Experiments based on syllabus: 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				
Course outcomes	**At the end of this course students will be able to-** 1. Formulate and analyze the Power Converter circuit 2. Analyse output waveform of Power converter circuit				

Course Title	**Microcontroller Lab**				
Course Code	**MENPE103P**				
Course Credits	**L**	**T**	**P**	**TC**	
	-	**-**	**2**	**1**	
Prerequisites	**Microcontroller Programming Commands**				
Course objectives	**This course will enable students-** • To study programming based 8051 microcontrollers, operations. • To study series and parallel communication of 8051with different interface				
Course Contents	**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 least significant digit 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.				

	13. Write a microcontroller 8051 program for counter 1 in mode 2 to count the pulses and display the state o the TL1 count on P2. Assume that the clock pulses are fed to pin T1. **14.** Write a microcontroller 8051 program to transfer letter "N" serially at 9600 baud, continuously. Assume crystal frequency to be 11.0592 MHz. **15.** Write a microcontroller 8051 program to transfer word "CSVTU" serially at 4800 baud and one stop bit, continuously. Assume crystal frequency to be 11.0592 MHz. Write a microcontroller 8051 program to receive bytes of data serially, and put them in P1. Set the baud rate at 2400 baud, 8-bit data, and 1 stop bit. Assume crystal frequency to be 11.0592 MHz.
Course outcomes	**At the end of this course students will be able to-** 1. Achieve Knowledge of programming development and experimentalskills in 8051 microcontrollers. 2. Develop their logics and programming skills of microcontroller

Elective-I

Course Title	**Analysis & Design of Artificial Neural Network**				
Course Code	**MENPE105TA**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Basics of Networks.**				
Course objectives	**This course will enable students-** • To understand model neuron and neural network and to analyse ANN learning and its application • To perform pattern recognition, linear classification • To design of other class of layered networks using deep-learning principles				
Course Contents	**UNIT – I** Pattern classification –Learning and generalization-structure of neural networks – ADA line and Made line-perceptron's. **UNIT – II** Linear separability – Back propagation – XOR function-Back propagation algorithm-Hopfield and Hamming networks- Kohen Sen's network-Boltzmenn machine-in and out star network – Art 1 and Art 2 nets **UNIT – III** Neuro adaptive control applications-ART architecture – Comparison layer – Recognition layer – ART classification process – ART implementation – Examples				

	UNIT – IV Character recognition networks, Neural network control application, connectionist expert systems for medical diagnosis Self organizing maps **UNIT – V** Applications of neural algorithms and systems: In Arts, in Bio-information, in Forecasting, in pattern & image recognition, Hardware implementation of Neural networks
Course outcomes	**At the end of this course students will be able to-** • Understand the concept of Artificial Neural Network. • Learn about different types of Neural network network • Learn about Neural Network training
Text Books	1. Martin T. Hogan, Howard B.Demuth, M, 'Neural network design' 4th edition,1996. 2. Zuroda, J.M.,'Introduction to Artificial Neural Systems', Jaico publishing house, Bombay, 1994. 3. Zimmermann, H.J., 'Fuzzy set theory and its applications', Allied publishers limited, Madras, 2000
Reference Books	1. Simon Haykins, 'Neural network- A Comprehensive foundation', prantice hall publication, 1999 2. Vojislav Kechman, 'Learning and soft computing', pearson

Elective-I

Course Title	**Modelling & Analysis of Electrical Machines**				
Course Code	**MENPE105TB**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Electrical Machines, Concept of Rotating Magnetic Field**				
Course objectives	**This course will enable students-** • To introduce the concepts of ideal synchronous machine and polyphase induction machine. • Application which will be utilized in the electrical machines with its performance and theory of operation • To study of special Machine				
Course Contents	**UNIT–I** Principles of Electromagnetic Energy Conversion, General expression of stored magnetic energy, coenergy and force/torque, example using single and doubly excited system. **UNIT-II** Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine. **UNIT-III** Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form; Application of reference frame theory to three phase symmetrical induction and synchronous machines, dynamic direct and quadrature axis model in arbitrarily rotating reference frames				

	UNIT –IV Determination of Synchronous Machine Dynamic Equivalent Circuit Parameters, Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine **UNIT- V** Special Machines - Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle, dynamic modeling and self controlled operation; Analysis of Switch Reluctance Motors.
Course Outcome	**At the end of this course students will be able to-** • Explain the theory of ideal synchronous machines and basic machines relations • Analyse and apply the concept of steady state analysis and electrical transients in polyphone machines • Make use of various control system of AC motors
Text Books	1. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans, 'Electric Machinery', Tata Mcgraw Hill, Fifth Edition, 1992. 2. R. Krishnan, 'Electric Motor & Drives: Modeling, Analysis and Control', Prentice Hall of India, 2001. 3. Miller, T.J.E,. 'Brushless permanent magnet and reluctance motor drives', Clarendon Press, Oxford, 1989.
Reference Books	1. Bhimra, 'Generalised Theory of Electrical Machines', Kanhapublicaation. 2. Kimbark,' Power System stability' , vol. 3, Wiely Publication 3. Adkins, ' General Theory of Electrical Machine'.

Elective-I

Course Title	**Digital Controllers in Power Electronics Application**				
Course Code	**MENPE105TC**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Power Electronics Devices, Digital Electronics**				
Course objectives	**This course will enable students-** • To give knowledge of digital control techniques applied to power converters • To give knowledge of discrete time control theory. • To give Simulating new developments in its application to switch power converters				
Course Contents	**UNIT–I** Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface , System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools. **UNIT-II** Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts , Interrupt Hierarchy , Interrupt Control Registers , Initializing and Servicing Interrupts in Software . **UNIT-III** ADC Overview , Operation of the ADC in the DSP , Overview of the Event manager (EV) , Event Manager Interrupts , General Purpose (GP) Timers , Compare Units, Capture Units And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information				

	UNIT–IV Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA , Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/Output Block (IOB) – Programmable Interconnect Point (PIP) – Xilinx 4000 series – HDL programming –overview of Spartan 3E and Virtex II pro FPGA boards- case study. **UNIT- V** Controlled Rectifier , Switched Mode Power Converters , PWM Inverters , DC motor control , Induction Motor Control
Course Outcome	**At the end of this course students will be able to-** • Formulate and analyse a power electronic design at the system level and access the performance • Identify the critical area in application level and drive typical alternative solutiuon with digital controller • Compare performance of various power semiconductor devices, its controller and switch circuit
Text Books	1. Hamid.A.Toliyat and Steven G.Campbell " DSP Based Electro Mechanical Motion Control " CRC Press New York , 2004 2. XC 3000 series datasheets (version 3.1). Xilinx,Inc.,USA, 1998 3. XC 4000 series datasheets (version 1.6). Xilinx,Inc.,USA, 1999 4. Wayne Wolf," FPGA based system design ", Prentice hall, 2004
Reference Books	1. P. Pirsch, "Architecture of Digital Signal Prosessing, John Weilly and sons 2. "Space-vector PWM with TMS 320C24X/F24X using hardware and software determined switching pattern.