M.Sc., Electronics -Model Programme structure Affiliated Colleges

S.No	Paper Code	Courses	Title of the paper	T/P	Credits	Hours/ Week	Marks		
	I Semester						**I**	**E**	**Total**
I	23MEL1C1	Core 1	Embedded Systems Design with PIC	T	5	6	25	75	100
	23MEL1C2	Core 2	Digital Communication Systems	T	5	6	25	75	100
	23MEL1P1	Core 3	Practical I - Embedded systems Design with PIC, Digital Communication and Digital Signal Processing	P	4	8	25	75	100
	23MEL1E1/ 23MEL1E2	DSE-1	Digital Signal Processing/ Digital Television Engineering	T	3	5	25	75	100
	23MEL1E3/ 23MEL1E4	DSE-2	Fundamentals of Python Programming /Instrumentation Control Techniques	T	3	5	25	75	100
					20	**30**	**125**	**375**	**500**
	II Semester								
II	23MEL2C1	Core 4	Embedded System Design with AVR	T	5	6	25	75	100
	23MEL2C2	Core 5	CMOS VLSI Design	T	5	6	25	75	100
	23MEL2P1	Core 6	Practical-II: Embedded System Design with AVR, VLSI design and Digital signal processor Programming	P	4	6	25	75	100
	23MEL2E1/ 23MEL2E2	DSE-3	Digital Signal Processor Programming and Applications/ Fiber Optics Communication	T	3	4	25	75	100
	23MEL2E3/ 23MEL2E4	DSE-4	Artificial Intelligence: Machine and Deep Learning / PC – Based Instrumentation	T	3	4	25	75	100
	23MEL2S1	SEC-1	Data Science for Research with Python	T	2	4	25	75	100
					22	**30**	**150**	**450**	**600**
	III Semester								
III	23MEL3C1	Core 7	Embedded System Design with ARM	T	5	6	25	75	100
	23MEL3C2	Core 8	Mobile satellite Communication Systems	T	5	6	25	75	100
	23MEL3C3	Core 9	Digital Image Processing	T	4	6	25	75	100
	23MEL3P1	Core 10	Practical -III: Embedded System Design with ARM and Digital Image processing	P	4	6	25	75	100
	23MEL3E1/ 23MEL3E2/ 23MEL3E3	DSE-5	Internet of Things with Raspberry Pi / Radar Engineering/ Biomedical Instrumentation	T	4	4	25	75	100
	23MEL3S1	SEC-2	Research Methodology for Scientific Research	T	2	2	25	75	100
	23MEL3I		Internship/Industrial Activity		2	-	25	75	100
					26	**30**	**175**	**525**	**700**
	IV Semester								
IV	23MEL4C1	Core 11	Nanoelectronics	T	5	6	25	75	100
	23MEL4C2	Core 12	Wireless Communication Systems	T	5	6	25	75	100
	23MEL4PR	Core 13	Project with Viva-Voce		6	10	25	75	100
	23MEL4E1	DSE-6	Biomedical Signal and Image Processing	T	4	4	25	75	100
	23MEL4S1	SEC-3	Biomedical Sensors	T	2	4	25	75	100
	--		Extension Activity		1				
					23	**30**	**125**	**375**	**500**
			Total		**91 +EC**		**575**	**1725**	**2300**

Core Courses

DSE – Discipline Specific Elective –Give more option to the student (Choice) and it may be conducted by parallel sessions.

SEC- Skill Enhancement Course

Dissertation- Marks -Vivo-voce (50) + thesis (100) + internal (50) = 200

Internship report –Marks -Vivo-voce (25) + reports (50) + internal (25) = 100

***AEC- Ability Enhancement Courses (may be included by altering the surplus credits and hours of other courses)**

I - Semester				
Course Code:	**Core Course - 1**	T/P	C	H/W
23MEL1C1	**Embedded System Design with PIC**	T	5	6

Objectives	To study the architecture of the PIC -CPU, Memory and Micro C Programming Techniques To understand Programming Parallel I/O Ports and how to Interface output devices To understand Programming internal ADC, DAC and PWM To understand how to handle Timers and interrupts To understand Serial communication Protocols, programming various protocols, interface communicate with GPS, Bluetooth Modules using serial communication protocols.
Unit - I	**PIC 18 Architecture and Embedded C Programming:** Architecture – WREG – File Register – Default Access Bank – Status Register – Program Counter - oscillator used in PIC - PIC Microcontroller Memory Types - Flash Program Memory, Data Memory (RAM) and EEPROM Data Memory - Program ROM Space - Embedded C Programming data types in MikroC Pro for Pic – Variables –Conditional and Looping statements– arrays and user defined functions.
Unit - II	**Programming Parallel I/O Ports:** Port A, B,C,D,E and F – Reading and Writing Registers in PIC microcontroller - I/O Bit Manipulation Programming - LED Blinking Program - 16×2 LCD Interfacing with PIC - 7 Segment Display interfacing with PIC - Stepper Motor Interfacing with PIC
Unit - III	ADC,DAC and PWM: PIC18F ADC Module - PIC18F ADC Block Diagram - PIC18F ADC Registers - IC18F4550 Microcontroller ADC Programming - PIC Microcontroller Built-in DAC Modules - DAC Module Control Registers - DAC Module Programming - PWM using PIC Microcontroller - PWM Duty cycle - PWM Programming - PWM for DC Motor Speed Control
Unit – IV	Timers and Interrupts in PIC microcontroller: Types of timers in PIC microcontroller - Clock source of PIC microcontroller timers - Delay Calculation of timers - Timers Registers Configuration - Working of PIC microcontroller timers - Code to generate delay with timers - Counter Programming - PIC 18 Interrupts – Programming Timer Interrupts – Programming External Hardware Interrupts
Unit - V	PIC Communication Modules : UART Communication with PIC- Use UART Interrupt of PIC - PIC SPI Module - I2C Communication using PIC - USB interfacing with PIC - Serial Communication Using PIC - GPS module interfacing with PIC - GSM Module interfacing with PIC - PIC Bluetooth module interfacing with PIC

Text Book:

Muhammad Ali Mazidi- Rolind D.Mckinlay- Danny Causey- *PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18*- Pearson -2013.

Books for Reference:

J.B. Peatman – 2009 - *Design with PIC Microcontroller*- Prentice Hall of India.

Myke Predko - 2008 - *PIC Microcontroller*- Tata McGraw Hill Edition.

Outcomes	The student will be able to develop skills to design their own Embedded System using PIC microcontroller and its internal modules for various applications

I - Semester				
Course Code:	**Core Course - 2**	T/P	C	H/W

23MEL1C2	**Digital Communication Systems**	T	5	6
Objectives	To know the principles of sampling & quantization To study the various waveform coding schemes To learn the various baseband transmission schemes To understand various Digital Modulation Schemes To Know the fundamental of channel coding and error control coding			
Unit - I	**Information Theory:** Digital Communication System - Discrete Memory less source, Information, Entropy, Mutual Information – Discrete Memory less channels – Binary Symmetric Channel, Channel Capacity – Hartley – Shannon law – Source coding theorem – Shannon – Fano & Huffman codes.			
Unit - II	**Waveform Coding & Representation:** Prediction filtering and DPCM – Delta Modulation – ADPCM & ADM principles-Linear Predictive Coding- Properties of Line codes- Power Spectral Density of Unipolar / Polar RZ & NRZ – Bipolar NRZ – Manchester			
Unit - III	**Baseband Transmission & Reception:** ISI – Nyquist criterion for distortion less transmission – Pulse shaping – Correlative coding – Eye pattern – Receiving Filters- Matched Filter, Correlation receiver, Adaptive Equalization.			
Unit – IV	**Digital Modulation Scheme:** Geometric Representation of signals – Generation, detection, PSD & BER of Coherent BPSK, BFSK & QPSK – QAM – Carrier Synchronization – Structure of Non-coherent Receivers – Principle of DPSK.			
Unit - V	**Error Control Coding:** Channel coding theorem – Linear Block codes – Hamming codes – Cyclic codes – Convolutional codes – Viterbi Decoder.			
Text Book Amitabha Bhattacharya, 2006Digital Communication, McGraw Hill Education (India) Pvt. Ltd. Bernard Sklar, Pabitra Kumar Ray, 2014Digital Communications Fundamentals and Applications, Pearson Education. Simon Haykin, 2005 Digital Communications , John Wiley India. Reference Books John G. Proakis, Masoud Salehi, 2014 Digital Communication, McGraw Hill Education Edition. K. Sam Shanmugam -2012- Digital and Communication Systems- Wiley-India. Nishanth N, 2017Digital Communication, Cengage Learning India. Ramakrishna Rao – 2011 Digital communication, Tata McGraw Hill Education Pvt. Simon Haykin, 2012 Communication Systems, 4/e Wiley India. Sudakshina Kundu – 2010 - Analog and Digital Communications- Pearson.				
Outcomes	The student should be able to design PCM system able to design base band transmission scheme able to design and implement band pass signaling scheme analyze the spectral characteristics of band pass signaling scheme able to design error control coding schemes			

I - Semester				
Course Code: 23MEL1P1	**Core Course - 3**	T/P	C	H/W
	Practical I - Embedded systems design with PIC, Digital Communication and Digital Signal Processing	P	4	8

Objectives	To understand interfacing I/O devices with PIC Parallel I/O and develop the embedded C programming in micropro IDE / MPLAB IDE To understand and develop timer, interrupt and Serial communication Programming To study Digital communication Modulators and Demodulators To Understand Starting of MATLAB Programming To develop MATLAB Programs to generate signals, Analyze the signal in Time domain and frequency domain To develop MATLAB Programs to design FIR and IIR Filters
	The DSP programs shall be implemented in software using MATLAB/C BCD and ASCII Conversion Testing PIC I/O Ports using LED and DIP switches Interfacing Traffic Light Controller Interfacing Seven Segment Display Interfacing Relay and Buzzer Interfacing LCD to PIC ADC Programming in PIC Interfacing Temperature Sensor to PIC Interfacing Stepper Motor to PIC Interfacing N x M Key Board to PIC DAC Interfacing in PIC Interfacing a DC Motor to PIC. Timer Program Event Counter Programmer Interrupt Programming PIC UART serial Interfacing Study of ASK modulation and Demodulation Study of FSK modulation and Demodulation Study of BPSK modulation and Demodulation Generation Of Basic Signals (unit impulse Signal, Step, Ramp, Exponential) Using Matlab Generate Continuous Time and Discrete time sin/ cosine signal. Compute Convolution of a given Sequence Compute Correlation of a given Sequence Compute Auto Correlation of a given Sequence Compute Cross Correlation of a given sequence Compute Correlation Coefficient of a given data Find frequency response of a given system given in (Transfer Function/ Differential equation form). Evaluate the impulse response of the system Find the DFT / IDFT of given signal Determination of Power Spectrum of a given signal(s). Implementation of windows Implementation of LP FIR filters for a given sequence. Implementation of HP FIR filters for a given sequence. Implementation of LP IIR filters for a given sequence. Implementation of HP IIR filters for a given sequence.
Outcomes	The student should be able to develop skill to design and implement Embedded System using PIC microcontroller able to design digital communication modulators and demodulators able to develop skill to coding MATLAB Program for Digital Signal Processing

I - Semester				
Course Code: 23MEL1E1	Discipline Centric Elective – 1 A	T/P	C	H/W
	Digital Signal Processing	T	3	5
Objectives	To Study types of Signals, analog to digital conversion of the signal using sampling To understand techniques and transforms required to analyze the signals in time domain and frequency domain Explain Pole zero description of discrete time systems Explain Classification of Digital filters and design FIR and IIR filters Explain Adaptive filters and design Adaptive filters using steepest decent, LMS algorithms			

Unit - I	**Discrete Time Signals and Systems:** Sampling Theorem- Sampling of Analog Signals – Anti Aliasing Filter - Various Types of Signals -Standard Discrete Time Signals – Classification of Discrete Time Signals – Basic Operations on DTS – Discrete Time Systems – LTI invariant System (Discrete Convolution)- Classification of DT LTI systems –DT Deconvolution and Correlation.
Unit - II	**Discrete Fourier Transformation:** Discrete Fourier Transform – Matrix Relation for Computing DFT and IDFT – Important Properties of DFT – Circular Convolution and its implementation – Linear Convolution from circular convolution –Decimation in Frequency FFT – Decimation in Time FFT – Radix -2 Inverse FFT – Frequency analysis of Known DT Signals – Power and Energy Spectral Density.
Unit - III	**Z Transformation**: The Z Transform – Properties of Z-Transform –The Inverse Z-Transform – Elements of a Digital Filters – Transfer Functions of a Difference Equation – The z-Plane Pole-Zero Plot -
Unit – IV	**Basics of Digital Filtering:** FIR Filter Structure – Properties of Linear Phase FIR Filters –Window Design Techniques – Design of Linear Phase FIR Filter Using Window- Generic Equation for IIR Filter - Design of Low Pass IIR Butterworth Filter – Design of Low Pass Chebyshev Filter
Unit - V	**Adaptive Filters:** Basic Adaptive Filter - System Identification - Noise Cancellation – Equalization - Adaptive Prediction - Computing the coefficients of an adaptive filter - The Steepest Decent Algorithm – LMS Adaptive Algorithm – Adaptive Noise Canceller - Adaptive System identification.

Reference Books

Alan V. Oppenheim and Ronald W. Schafer , *Digital Signal Processing*,

Reddy, 2009 " *Biomedical Signal Processing Principles and Techniques*, The Tata-McGraw – Hill Publishing Company Ltd, New Delhi.

Dr. ShailaD.Apte, 2010 *" Digital Signal Processing*", WILEY INDIA. John G. Proakis, Dimitris

G. Monolakis, 2011 "*Digital Signal Processing Principals, Algorithms and Applications*", PEARSON.

eerghaRao, M.N.S.Swamy, 2012 *" Digital Signal Processing*", JAICO Publishing House.

Roberto Cristi, 2012 *"Modern Digital Signal Processing*", CENGAGE Learning.

S. Salivhanan, " *Digital Signal Processing* , IV Edition, McGraw-Hill

y K. Ingle, John G. Proakis, 2012 *"Essentials of Digital Signal Processing Using MATLAB",* CENGAGE Learning, Third Edition.

s J. Tompkins , 2000 " *Biomedical Digital Signal Processing,* Prentice - Hall of India Pvt. Ltd.

Y.Yong, Tae G. Chang, IK H. Song, Yong S.Cho, J.Heo, Won G.Jeon, JeongW.Lee, and Jae K.Kim, 2001 *" Signals and Systems with MATLAB",* Springer International Edition.

Outcomes	Able to develop algorithm to analyze the discrete time signal and systems in time domain using convolution and correlation Able to develop an algorithm to analyze the discrete time signals in frequency domain using DFT and FFT Able to develop an algorithm to design and analyze the FIR and IIR filters using Z – transform Able to develop an algorithm to design adaptive filters for system identification, noise cancellation and Equlization

I - Semester				
Course Code: 23MEL1E2	Discipline Centric Elective –1 B	T/P	C	H/W
	Digital Television Engineering	T	3	5
Objectives	Illustrate the fundamentals of television engineering. Explain the colour TV transmission and reception Compare Digital TV transmission standards Discuss factors affecting system noise and transmission errors Explain the Digital TV transmission and reception and Describe the operation of LCD			
Unit - I	Introduction: TV transmitter and receivers- synchronization Television Pictures: Geometric form and aspect ratio- image continuity- interlaced scanning- picture resolution. Composite video signal: Horizontal and vertical sync details. TV Signal Transmission: VSB transmission, standard channel BW, TV transmitter			
Unit - II	Colour Television: Perception of brightness and colours,-additive colour mixing – video signals for colours- luminance signal- colour difference signals- encoding of colour difference signals - formation of chrominance signals - PAL encoder - PAL colour receiver			
Unit - III	Digital Television Transmission Standards: ATSC terrestrial transmission standard - vestigial sideband modulation- DVB -T transmission standard- ISDB-T transmission standard- channel allocations- antenna height and power, MPEG-2.			
Unit – IV	Performance Objectives for Digital Television: System noise - external noise sources- transmission errors- error vector magnitude- eye pattern- interference, co- channel interference- adjacent channel interference -analog to digital TV, transmitter requirements.			

Unit - V	Digital Television: Digital System Hardware - Signal Quantization and Encoding- Digital Satellite Television- Direct to Home Satellite Television- Digital TV Receiver- Merits of Digital TV Receivers- LCD Technology, LCD Matrix types and operation- LCD Screens- LCD color receiver.

ooks:

A.M. Dhake, *Television and Video Engineering* –2nd Edition, Tata McGraw Hill

Gerald W. Collins, *Fundamentals of Digital Television Transmission*- John Wiley & Sons. Publishers.

R G Gupta, *Television engineering and video systems* –Tata McGraw Hill Publishers.

R. R.Gulati, *Modern Television Practice: Transmission, Reception and Applications*,4th Revised edition, New Age International Publishers.

References

Bernard Grob, *Basic Television and Video Systems* –McGrawHill Publishers.

R RGulati, *Monochrome and Colour Television* - New Age International Publishers. S.P.Bali, *Colour Television, Theory and Practice* Tata McGraw-Hill Publishers.

Outcomes	Course Outcomes: After Successful completion of the Course, the student will be able to understand the transmission and reception of digital TV and gain trouble shooting knowledge.

I - Semester				
Course Code: 23MEL1E3	Discipline Centric Elective –2 A	T/P	C	H/W
	Fundamentals of Python Programming	T	3	5
Objectives	To know need of Python, Features of Python, Python IDE , variables, Data Types and statements To understand List,Tuples, Sets and Dictionary in Python To understand conditional, loop statements and its format To understand handling of arrays and user defined functions To understand concept of Python classes, inheritance, polymorphism and objects			
Unit - I	**Introduction to Python:** Why Learn Python? - Features of Python - Characteristics of Python Programming - Applications of Python - Python Versions – Python IDE – Installing Python – Getting Started with Python Coding - Interactive Mode - Script Mode - Using IDE - Python Syntax – Identifiers - Reserved Words - Writing Python Comments – Expression – Assignment Statement -The input() function – User Output - File Handling - Operations on Files - Methods in File Handling - Python Data Types – Variables - Python Class Variables - Python Numbers - Types of Operators in Python			

Unit - II	**List and Tuples in Python:**Creating a Lists - Creating Multi-dimensional Lists in Python - Python List Comprehension - Python Lists Extension - Accessing Lists in Python - Length of List in Python - Linked List in Python - List to String in Python - Common_List_Operations_in_Python - Python List Functions and Methods - Advantages of Tuples in Python over Lists - Creating a Tuple in Python - Tuple length in Python - Accessing Python Tuple Elements - Indexing of Tuples in Python - Reveres Indexing of Tuples in Python - Slicing Operator of Tuples in Python - Performing Operations in Tuples in Python - Modifying Elements in a Python Tuple - Deleting Python Tuple Elements - Difference between list and tuple in python - Python List of Tuples - List to Tuple in Python.
Unit - III	**Python Set and Dictionary:** Instantiate a Set in Python - Python Set Operations – Common Python Set Functions - Frozenset in Python - Python Ordered Set - Difference between set and list in Python - Convert list to set in Python - Convert set to list in Python - Python Dictionary: Iterate a Dictionary in Python - Access Items in Dictionary in Python - Operations in Dictionary in Python - Loop Through a Dictionary in Python - Add Items to a Dictionary in Python - Remove Items from a Dictionary and Delete the Whole Dictionary in Pyhton - Python Dictionary Length - Checking All Keys in a Dictionary in Python - Sort Dictionary by value in Python - Update Dictionary - Nested Dictionary in Python - Ordered Dictionary in Python - Dictionary Comprehension in Python - Convert list to Dictionary in Python - Common Python Dictionary Methods
Unit – IV	**Python Conditional Statements, Function and Arrays - Control Flow Statements Conditionals:** if-Else Constructs - Loop Structures/ Iterative Statements - While Loop -For Loop - Break Statement - Functions in Python: Defining a Function in Python - Calling a Function in Python - Adding a Docstring in Python Functions - Scope of Variables in Python Functions - Main Function in Python - Functions of Lambda in Python - Properties of Lambda Functions - Lambda Function with map() in Python - Lambda Function with
	filter() in Python - Built in Functions in Python-Array in Python : Array Vs List in Python - Creating an Array in Python 3 - Accessing a Python Array Element - Basic Operations of Arrays in Python - 2D Arrays in Python - Dynamic Array in Python - Array Input in Python - Array Index in Python - Array Programs in Python - Python Array vs List
Unit - V	**Concept of Python** : What is an Object in Python? - Concept of Python Class - Example of Python Classes and Objects - Advantages of Using Classes in Python - Creating a Python Class - Creating an Object in Python - Types of Classes in Python - Python Abstract Class - Python Concrete Class - Python Partial Class - The __init () Function in Python - Python Inheritance and Its Types - Python Polymorphism - Mutable and Immutable Objects in Python

Reference Books

neth A. Lambert, Martin Osborne, 2012 *Fundamentals of Python*: First Programming, Course Technology Cengage Learning.

naThareja, 2017 *Python Programming Using Problem Solving Approach'* Cofound University Press.

ı B, Downey, 2016 *"Think Python: How to Think Like a Computer Scientist",* Second Edition, Shroff/O'Reillly Publishers.

o vanRossum, Fred L.Drake Jr., 2011 *"An introduction to python* - Revised and Updated for python 3.2*"*. Network Theory ltd.

V Guttag, 2013 *"introduction to computation and programming Using python*", Revised and Expanded Edition, MIT press.

Outcomes	The student should be Able to develop skill on coding python in python IDE Able to handle List, Tuples, sets and Dictionaries in Python Able to develop skill to develop python simple programs using statements Able to develop skill to handle arrays and user defined functions Able to develop skill to handle objects, classes, inheritance, polymorphism Able to develop skill to develop codes for Data analytic, Digital Signal and Image processing using Python.

I - Semester				
Course Code: 23MEL1E4	Discipline Centric Elective –2 B	T/P	C	H/W
	Instrumentation Control Techniques	T	3	5
Objectives	To learn the concept of measurement and error estimation To learn various industrial detection sensor and its interfacing To learn to design data acquisition systems To learn DC motor construction, operations and its drive To know industrial control techniques.			
Unit - I	Measurement: Performance characteristics of instruments- Static characteristics- Accuracy- Resolution-Precision- Expected value- Error- Sensitivity- Errors in Measurement, Dynamic Characteristics- speed of response- Fidelity- Lag and Dynamic error.			
Unit - II	Industrial Detection Sensors and Interfacing: Proximity Detectors – Inductive Proximity Switches – Capacitive Proximity Switches – Hall Effect Sensor –IC Temperature Sensor – Optical Shaft Encoder Displacement Sensor - Photoelectric Sensor – Methods of Detection –Ultrasonic Sensors – Sensor Interfacing.			
Unit - III	Data acquisition and Handling: systems: Introduction-signal conditioners-Instrumentation amplifiers-filters- Data conversion - multiplexers-A/D-D/A conversion - PC based telemetry System.			

Unit – IV	DC Motor and Variable Speed Drive: DC Motor: Principles of Operation - Practical DC Motor - Basic Motor Construction – Motor Classification – Coil terminal Identification – DC Servo Motor – Stepper Motor – Permanent Magnet Stepper Motor – Variable Reluctance Stepper Motor DC drive Fundamental – Variable Voltage DC drive – Motor Breaking .
Unit - V	Process Control- Techniques and Control Methods: Pressure Control system - Temperature Control System– Flow Control System – Level Control System – Analytical Instrumentation – Non Destructive Testing – Open Loop Control – Closed Loop Control – Single Variable Control – Selecting a Controller – On-Off Control – Case Study – Continuous Control – Tuning the Controller.

Text Books:

Nakra and K.K.Chaudhry (2004) *Instrumentation- Measurement and Analysis*- Tata McGraw Hill Second Edition

Bartelt (2006), *Industrial Electronics Circuits*- Instruments and Control Techniques- Cengage Learning

Books for Reference:

Bimal K.(2004), *Bose Modern Power Electronics and AC Drives*, Pearson Education.

anath paul(2005), *Industrial Electronics and Control*, Prentice Hall of India. I.J. Nagrath and M.Gopal (1995) *Control Systems Engineering*- New Age International Pvt. Ltd.,

Mathivanan (2009) PC, *Based Instrumentation Concept and Practice*, Prentice Hall of India.

S.N. Biswas(2000), *Industrial Electronics*, Dhanpat Rai & Co

Outcomes	Course Outcomes: After Successful completion of the Course, the student will be able to understand the measurement, instrumentation and control system design and function.

II - Semester				
Course Code: 23MEL2C1	**Core Course - 4**	T/P	C	H/W
	Embedded System Design with AVR	T	5	6
Objectives	To study the architecture of the PIC -CPU, Memory and AVR studio IDE to develop Embedded C Programming Techniques To understand Programming Parallel I/O Ports and how to Interface output devices To understand how to handle Timers, interrupts and PWM To understand UART Serial communication Protocols, I^2C and SPI, programming protocols To understand interfacing and programming of various real time devices.			
Unit - I	**AVR Architecture and Embedded C Programming:** AVR General Purpose Registers – Data Memory – Status Register – Program Counter – Program ROM Space – RISC Architecture in the AVR - Data Types- Operators and Expressions – Control flow – Input and Output – Functions – Pointers – Arrays – Structures – Unions – Type Definition - Time Delays in C – I/O Programming in C – Logic Operations in C – Data Conversion Program in C – Data Serialization in C - Memory Allocation in C – ATMEGA 32 Pin Connection – AVR Fuse Bits – Hex File for AVR – AVR Studio IDE to Develop C Programs.			
Unit - II	**Programming I/O Ports:** I/O Ports in AVR – Programming its Registers to Perform input and output Port - I/O Bit Manipulation Programming – LED Blinking Program - 16×2 LCD Interfacing with AVR – 7 Segment Display interfacing with AVR - Stepper Motor Interfacing with AVR			

Unit - III	**Timer , Interrupts and PWM Programming:** Timers 0- 1 and 2 – Counter Programming – Programming Timers in C – AVR interrupt – Programming Timer Interrupts – Programming External Hardware Interrupts – Interrupt Priority – Interrupt Programming in C –Wave Generation using Timer1- Time Delay using Timer - PWM Modes in 8 bit Timers – PWM Modes in Timer 1.
Unit – IV	**AVR Serial Port Programming in C- SPI and I2C Protocol:** Basic of Serial Communication – ATMEGA32 Connection to RS232 – AVR Serial Port Programming in C – AVR Serial Port Programming in C using Interrupts – SPI Bus Protocol – SPI Programming in AVR – I2C Bus Protocol – TWI (I2C) in the AVR – AVR TWI Programming in C.
Unit - V	**Interfacing With AVR:** Keyboard Interfacing – ADC Interfacing – DAC Interfacing – Sensor Interfacing – Relays and Optoisolators Interfacing – DC motor Control using PWM – MAX 7221 Interfacing and Programming – DS 1307 RTC Interfacing and Programming – TWI Programming with Checking Status Register.
Text Book: di / Naimi / Naimi – 2013- *The AVR Microcontroller and Embedded Systems: Using Assembly and C*- Pearson Education India; 1st edition. Thomas Grace , 2015 *Programming And Interfacing Atmel Avr Microcontrollers*, Cengage Learning. **Book for Reference:** HAN – WAY HUANG - 2014 - *The ATMEL AVR Microcontroller MEGA and XMEGA in Assembly and C*- CENGAGE Learning	
Outcomes	The student will be able to develop skills to design their own Embedded System using AVR microcontroller and its internal modules for various applications using AVR studio IDE

II - Semester				
Course Code: 23MEL2C2	**Core Course - 5**	T/P	C	H/W
	CMOS VLSI Design	T	5	6
Objectives	Understand CMOS Logic, Technology , Characterisation and Performance Estimation Digital system design using HDL. Understand configuring and implementing digital system design on FPGA using HDL			
Unit - I	**Introduction to CMOS Logic:** MOS Transistors – CMOS Logic - CMOS Fabrication and Layout – Invertor Cross Section – Fabrication Process – Layout Design Rules – Gate Layout – Stick Diagram – VLSI Design flow – Design Specification – Design Entry – Functional Simulation – Planning Placement and Routing – Timing Simulation – Fusing/Fabrication into the Chip			
Unit - II	**CMOS Technology:** MOS Transistor Theory – Ideal I-V Characteristics – Non-Ideal I-V Effects – Complementary CMOS Inverter DC Characteristics – CMOS Technologies – Layout Design Rules – CMOS Process Enhancements – Technology-Related CAD Issues – Manufacturing Issues			
Unit - III	**Circuit Characterization and Performance Estimation**: Delay Estimation – Power Dissipation – Interconnect – Design Margin – Reliability Terminology – Scaling			
Unit – IV	**Combinational and Sequential Circuit Design:** Static CMOS Dynamic Circuits – Low-Power Logic Design – Circuit Design of Latches and Flip- Flops - **CMOS Testing:** Logic Verification Principles – Silicon Debug Principles – Manufacturing Test Principles – Design for Testability – Boundary Scan			

Unit - V	**Hardware Descriptive Language** : Behavioral Modeling with Continuous Assignments – Basic Constructs - Behavioral Modeling with Always Blocks – Finite State Machines – Parameterized Modules – Structural Primitives – Test Benches

Text Books

Jose Anand- -2014 *VLSI Design*- Vijay Nicole Imprints Private Limited- Chennai Neil H.E.Weste, David Harris, Ayan Banerjee, 2006 *CMOS VLSI Design A Circuits and System Perspective*, Pearson Education

Books for Reference:

s A. Pucknell -2011- Kamran Eshraghian- *Basic VLSI Design*- Prentice Hall of India Pvt. Ltd.

s L. Perry –2012 - *VHDL Programming By Example*- Tata McGraw Hill Education Pvt. Ltd.

ı Eshraghian- Douglas A. pucknell -2011- Sholeh Eshraghian-*Essentials of VLSI Circuits and Systems*- Prentice Hall of India Pvt. Ltd

M.J.S. Smith, 2000 "*Application Specific Integrated Circuits*", Pearson. Peter Ashenden, 2007 "*Digital Design using Verilog*", Elsevier.
Peter Ashenden, 2007 "*Digital Design using VHDL*", Elsevier.

L.Geiger- Phillip E.Allen- Noel R.Strader– 2010 - *VLSI Design Techniques for analog and Digital Circuits*- Tata McGraw Hill Education Pvt. Ltd.
Wolf, 2004 *"FPGA based system design*", Pearson,.Clive Maxfield, 2004 "*The Design Warriors's Guide to FPGAs*", Elsevier.

Outcomes	Model Combinational and sequential digital circuits by Verilog HDL Design and model digital circuits with Verilog HDL at behavioural, structural, and RTL Levels Develop test benches to simulate combinational and sequential circuits. Understand the FPGA Architecture Implementation of the combinational and sequential digital circuits in FPGA

II - Semester				
Course Code: 23MEL2P1	**Core Course - 6**	T/P	C	H/W
	Practical – II: Embedded System Design with AVR, VLSI design and Digital signal processor Programming	P	4	6
Objectives	To design an embedded hardware and interfacing with AVR To develop the embedded C codes using AVR studio IDE To study and learn to program timer, interrupt, serial communication and other real time interfacing To develop digital system design using xilinix FPGA programming using VHDL program			

	Testing AVR I/O Ports using LED and DIP switches Interfacing Seven Segment Display Interfacing LCD Interfacing Temperature Sensor to AVR Interfacing Stepper Motor to AVR Interfacing N x M Key Board to AVR Interfacing a DC Motor using PWM Interfacing Traffic Light Controller AVR Timer Programming Event Counter Programmer Interrupt Programming AVR Serial Communication Programming Half and Full Adder Half and Full Subtractor Flip-flops Counters Registers Multiplexer De multiplexer Encoder Decoder Xillinx FPGAs – Traffic light Controller Waveform Generation MAC Operation using Various Addressing Modes Implement Linear Convolution Implement Circular Convolution Implement FFT Implement Windowing Techniques Implement FIR Filter Implement IIR Filter
Outcomes	The student should be Able to design and develop and embedded hardware and software for AVR microcontroller Able to program on AVR studio IDE Able to design combinational and sequential digital circuits using xilinix FPGA program Able to develop FPGA programming codes using VHDL/Verilog Able to develop C code using code composer studio IDE Able design and implement convolution, FFT and implement FIR and IIR filter design using MATLAB

II - Semester				
Course Code: 23MEL2E1	Discipline Centric Elective – 3 A	T/P	C	H/W
	Digital Signal Processor Programming and Applications	T	3	4

Objectives	To understand elements of digital signal processing systems, data formats and various errors To understand the architecture of the digital signal processor to increase the speed To study the architecture of the TMS 320 C 5416 architecture, Memory Space and External Bus interfacing signals To understand interfacing memory and parallel , DMA and Serial Interface and know about CODEC To know the code composer Studio IDE and how to develop C programming and Run the C Programming.
Unit - I	**Introduction to Digital Signal Processing:** Digital Signal Processing Systems – Digital Filters – Fixed Point Format – Double Precision Fixed Point Format – Floating Point Format – Dynamic Rang and Precision – Sources of Error in DSP Implementations – A/D conversion Errors – DSP Computational Errors – D/A Conversion Errors – Compensating Filter.
Unit - II	**Architecture for Programmable DSP Devices:** DSP Computational Building Blocks –Bus Architecture and Memory – Addressing Capabilities – Address Generation Unit – Program Control – Program Sequence – Hardware Architecture – Parallelism – Pipelining – Features for External Interfacing.
Unit - III	**Architecture of TMS320C54XX DSP Processor:** Bus Structure – CPU – Internal Memory – Memory Mapped Registers – Addressing Modes – Memory Space – Program Control – Instruction Sets – Programming – On- chip Peripherals – Interrupts - Pipeline - Memory Space Organization – External Bus Interfacing Signals
Unit – IV	**Interfacing Memory and Parallel I/O Devices:** Memory Interface – Timing Sequence for External Memory Access – Wait States – Parallel I/O Interface – Programmed I/O – Interrupts and I/O – DMA Operation – Synchronous Serial Interface – McBSP – McBSP programming – A CODEC Interface Circuit – CODEC.
Unit - V	**DSP Development System:** DSP Support Tools – DSP System Design Kit – Code Compose Studio – Useful Types of Files - Software for Development – The Assembler and the Assembly Source File – The Linker and Memory Allocation – C/C^{++} Compiler – FIR Filter Implementation - Speech Processing – An Image Processing

Reference Books

Avtar Singh and S.Srinivasan – 2004- *Digital Signal Processing Implementations*- Cengage Learning.

B.Vengatramani and M.Bhaskar- 2002- *Digital Signal Processors Architecture- Programming and Applications*- Tata McGraw-Hill

Rulph Chassaing, *2005 Digital Signal Processing and Applications with the C 6713 and C6416 DSK,* Wiley,

V. Udayashankara 2012- *Modern Digital Signal Processing includes Signals and Systems*- Prentice Hall of India- Second Edition .

S.Salivahanan and C.Gnanpriya– 2012 - *Digital Signal Processing*- McGraw-Hill- Second Edition

Sen M. Kuo, Woon-Seng S. Gan, 2012 *Digital Signal Processors, Architectures, Implementations, and Applications*, Pearson.

Vinay K. Ingle and John G.Proakis – 2008- *Digital Signal Processing A MATLAB Based Approach*.

Outcomes	The student should be to develop skill to develop DSP algorithm using Code composer Studio develop skill to design DSP System using TMS320C5416 DSK

II - Semester				
Course Code: 23MEL2E2	Discipline Centric Elective – 3 B	T/P	C	H/W
	Fiber Optics Communication	T	3	4

Objectives	Describe the overview of optical fiber communication, ray theory transmission and Concepts of modes. Explain thoroughly the operation of optical sources, Quantum efficiency and power. Classify different types of optical detectors and also explain the operation of optical Receiver. Illustrate the concept of power launching and power coupling for optical fibers. Discuss splicing techniques and connector losses. Construct optical link and becomes familiar with WDM concepts and measurement Techniques.
Unit - I	Introduction - Advantages of optical fiber communications - Optical fiber wave guides - Ray theory transmission- Total Internal Reflection- Acceptance angle- Numerical Aperture, Skew rays- Cylindrical fibers- Modes -- V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers - Cut off wavelength, Mode Field Diameter.
Unit - II	Optical sources-LEDs, Structures, Materials- Quantum efficiency- Power, Modulation- Power bandwidth product- Injection Laser Diodes- Modes, Threshold conditions- Laser diode rate equations- External quantum efficiency- resonant frequencies
Unit - III	Optical detectors- Physical principles of PIN and APD- Detector response time- Temperature effect on Avalanche gain- Comparison of Photo detectors- Optical receiver operation - Fundamental receiver operation- Digital signal transmission- error sources- Receiver configuration- Digital receiver performance- Probability of Error- Quantum limit- Analog receivers.
Unit – IV	Source to fiber power launching-Output patterns- Power coupling- Power launching- Equilibrium Numerical Aperture- Lensing Schemes for Coupling, Laser diode to fiber coupling- Fiber to Fiber joints – Mechanical misalignment, Fiber related losses- End face preparation- Fiber Splicing-Splicing techniques- Splicing single mode fibers-Optical fiber Connectors-Connector types, Single mode fiber connectors, Connector return loss- Multimode fiber joints- Single mode fiber joints.
Unit - V	Optical system design - Point-to- point links- System considerations- Link power budget- Rise time budget with examples- Line coding in Optical links- Operational Principles of WDM- Measurement of Attenuation and Dispersion- Eye pattern.

TEXT BOOKS:

eiser,(2000) *Optical Fiber Communications* , McGraw-Hill International edition, 3rd Edition.

P. Agarwal, (2004)*Fiber Optic Communication Systems*, John Wiley, 3rd Edition.

R.P. Khare, (2004) *Fiber Optics and Optoelectronics*, Oxford University Press. RERFERENCES:

K. Mynbaev, 2005.S.C. Gupta and Lowell L.Scheiner, Fiber Optic Communications, Pearson Education.

S.C.Gupta, 2005. *Text Book on Optical Fiber Communication and its Applications* –PHI,

Joseph C. Palais, 2004. *Fiber Optic Communications*, 4th Edition, Pearson Education,

Outcomes	Understand the need of optical communication and its applications

II - Semester				
Course Code: 23MEL2E3	Discipline Centric Elective – 4 A	T/ P	C	H/W
	Artificial Intelligence: Machine and Deep Learning	T	3	4
Objectives	To understand AI and Machine Learning Basics To understand types of Machine learning and its applications To understand Deep learning and neural networks and its applications			

Unit - I	**Machine Learning Basics:** Introduction to Artificial Intelligence - Introduction to Machine learning – Types of Machine Learning: Supervised Learning - Unsupervised Learning - Semi-supervised Learning - Reinforcement Learning - Gathering Datasets for Machine Learning - Structured Dataset - Unstructured Dataset for Machine - List of Open-source Datasets for Machine Learning
Unit - II	**Supervised and Unsupervised Machine Learning Algorithms :** Supervised Machine Learning Algorithm – working of Supervised Machine Learning Algorithm–Regression in Machine Learning - Linear Regression - Classification in Machine Learning: Naive Bayes – Logistic Regression – SVMs- Decision Tree – Random Forest – K Nearest Neighbor – K-means Clustering – Principal Component Analysis.
Unit - III	**Overview of Deep Learning :** Introduction to Deep Learning – Need of Deep Learning – Deep Learning Vs Machine Learning - Biological Neural Network vs Artificial Neural Network - Neural Networks Work in Deep Learning - Single Layer Perceptron and Multilayer Layer Perceptron - Deep Neural Network - Working Explanation
Unit – IV	**Introduction to Neural Networks:** Artificial Neural Networks - Structure of Neural Network - Artificial Neuron - Weights and Bias - Input layer, Hidden layer and Output layer - Activation Function - Sigmoid or Logistic - Tanh—Hyperbolic tangent - ReLu - Rectified linear units - Feed Forward and Backpropagation Neural Networks.
Unit - V	**Types of Neural Network and its Applications:** Convolutional Neural Network(CNN) - Recursive Neural Network(RNN) - Recurrent neural network (RNN) - Long short-term memory (LSTM) - Deep Learning with Tensor Flow using (MNIST) dataset - Images segmentation – Object Detection - Video to Text with LSTM models

Reference Books:

Andress C. Muller and Sarcah Guido , 2016 Introduction to Machine Learning with Python, O'REILLY.

Francois Chollet, 2018 "Deep Learning with Python", Manning Publications.

Ian J. Goodfellow, Yoshua Bengio, Aaron Courville, 2017 "Deep Learning", MIT Press.

Joshua F. Wiley, 2016 "R Deep Learning Essentials", Packt Publications.

Navin Kumar Manaswi, 2018 "Deep Learning with Applications Using Python", Apress.

Phil Kim, 2017 "Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress.

Ragav Venkatesan, Baoxin Li, 2018 "Convolutional Neural Networks in Visual Computing", CRC Press,.

Rudolph Russell, 2018 Machine Learning: Step-by-Step Guide To Implement Machine Learning Algorithms with Python.

Sayan Mukhopadhyay, 2018 Advanced Data Analytics Using Python: With Machine Learning, Deep Learning and NLP Examples, Apress,

Outcomes	The student should be Able to collect data and to develop the skill to apply various machine learning for data analytic using matlab and python programming Able to use deep learning and neural networks to find the accuracy of the system design using python

II - Semester				
Course Code: 23MEL2E4	Discipline Centric Elective – 4 B	T/P	C	H/W
	PC – BASED INSTRUMENTATION	T	3	4
Objectives	To design a circuit to acquire and amplify the signal To design digital system using basic requirements To know the PC hardware required to acquire and process the data To know data transmission using various network techniques.			

Unit - I	Signal Conditioning and Op-Amps Circuits and Sensors: PC- Based Instrumentation System – Amplifiers – Bridge Circuits – Filters – Other Op-amp Circuits – Noise and Noise Reduction Techniques – IC Temperature Sensors – Comparing Temperature Sensors – Piezoelectric Sensor – Electrical Type Pressure Sensor – Flow Sensors.
Unit - II	Principles of Data Acquisition: Sampling Concepts – Digital to Analog Converters – Analog to Digital Converters- Data Acquisition Systems – Data Acquisition Configurations.
Unit - III	Hardware Organization of IBM PC and Interfacing to IBM PC: Mother Board Components – System Resources – System and Peripheral Control Chips – Expansion Buses ISA Bus – EISA Bus – PCI Bus - I/O Ports – Peripherals – ADC Board – DAC Board – Digital I/O Board – Timing I/O Board – General Purpose Plug-in DAQ Board – PCI Plug-in DAQ Board.
Unit – IV	Data Acquisition Using GPIB and Serial Interface: Over View of GPIB – GPIB commands – GPIB Programming – Expanding GPIB – IEEE-488.2 –SCPI Command Structure – HS488 Protocol – Serial Communication – Serial Interface Standards – PC Serial Port.
Unit - V	Networked Data Acquisition: Network Data Communication – Local Area Networks – HART Communication – Field buses.
Text Book: N. Mathivanan- 2009, *PC-Based Instrumentation Concepts and Practice*- Prentice Hall of India Pvt. Ltd- New Delhi **Books for Reference**: A. Gayakward, 2005 *Op-Amps and Linear Integrated Circuits*- Prentice Hall of India. Albert D. Helfrick- William D.Cooper, 2012, Prentice Hall of India. B. Govinda Rajulu- *IBM Clones*- Tata McGraw Hill Behrouz A Forouzan- *Data Communications and Networkings*- Tata McGraw Hill Kalasi H.S- *Electronic Instrumentation*- Tata McGraw Hill. Rangan- Mani- Sharma- *Instrumentation Devices and Systems*- Tata McGraw Hill	
Outcomes	Understand and acquired knowledge of the PC-Based instrumentation techniques and design

II - Semester				
Course Code: 23MEL2S1	Skill Enhancement Course - I	T/P	C	H/W
	Data Science for Research with Python	T	2	4
Objectives	To understand data analysis To understand sampling and distributions To do Statistical Experiments and Significance Testing using Python To perform data preprocesssing and visualization techniques using Python To do dimensionality reduction and apply for machine learning techniques			

	using python packages
Unit - I	**Exploratory Data Analysis** Elements of Structured Data- Rectangular Data- Estimates of Location- Estimates of Variability- Exploring the Data Distribution- Exploring Binary and Categorical Data- Correlation- Exploring Two or More Variables
Unit - II	**Data and Sampling Distributions** Random Sampling and Sample Bias- Selection Bias- The Bootstrap- Confidence Intervals- Normal Distribution- Student's t-Distribution- Binomial Distribution- Chi-Square Distribution- Poisson Distributions-Exponential Distribution.
Unit - III	**Statistical Experiments and Significance Testing:** Hypothesis Tests- Resampling- Statistical Significance and p-Values- t-Tests- ANOVA- Chi-Square Test- Regression and Prediction- Simple Linear Regression- Multiple Linear Regression- Polynomial and Spline Regression - Logistic Regression.
Unit - IV	**Data Pre-processing and Visualization** Introduction- data representation-data transformation -data cleaning - Data Integration-Data Transformation-Data in Different Scales-Data Discretization - Data Visualization: Introduction- Functional Approach- Object-Oriented Approach Using Subplots
Unit - V	**Dimensionality Reduction and supervised and Unsupervised Learning:** Python machine learning libraries: Pandas –NumPy-Matplotlib-Seaborn-scikit-learn - Train and Test Data-Supervised Learning-Classification-Regression-Time series analysis - Performance Metrics: Confusion matrix-Precision-Recall-Accuracy-F1 score - Hierarchical Cluster Analysis (HCA)-K-means Clustering-Principal Component Analysis (PCA)-Supervised Data Compression using Linear Discriminant Analysis (LDA) References

References

1. Peter Bruce, Andrew Bruce, Peter Gedeck, Practical Statistics for Data Scientists, 2nd Edition, Released May 2020 Publisher(s): O'Reilly Media, Inc.
2. Rohan Chopra, Aaron England, Master Data science with Python, Packt Publications, 2019
3. Stephen Klosterma**n,** Data Science Projects with Python : A case study approach to successful data science projects using Python, pandas, and scikit-lear**n,** Packt Publications , 2019
4. Sebastian Raschka, Vahid Mirjalili, Python Machine Learning : Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, Third Edition, Packt Publications , 2019
5. Carlos Fernandez-Granda, Probability and Statistics for Data Science, 2017 https://cims.nyu.edu/~cfgranda/pages/stuff/probability_stats_for_DS.pdf

Out Comes	After completing this course the student can able to apply their skills for data analysis and Artificial intelligence for scientific research

III - Semester				
Course Code: 23MEL3C1	**Core Course - 7**	T/P	C	H/W
	Embedded System Design with ARM	T	5	6
Objectives	To study the ARM7 Architecture, pin diagram and memories of LPC2148 To understand system control, memory map, pin connect block and GPIO register descriptions for programming To understand timer, interrupt and serial communication register descriptions and learn to programme. To understand I2C, SPI and PWM concept and learn to programme To understand interfacing I/O devices and learn to programme			

Unit - I	**ARM7 Microcontroller Architecture:** Introduction to the ARM Microcontrollers – ARM Processor Family – Applications of ARM Processor – LPC2148 ARM 7 Microcontroller – Features of LPC2148 – Block Diagram of LPC2148 – Pin Diagram of LPC2148 – Architectural Overview – On-Chip Flash Program Memory – On-Chip Static RAM.
Unit - II	**System Control- Memory Map- Pin Connect Block- GPIO :** Crystal Oscillator – PLL – Reset and Wake-Up Timer – Brownout Detector – Code Security – External Interrupt Input – Memory Mapping Control – Power Control- VPB – Memory Map – Pin Connect Block – General Purpose I/O Register Description
Unit - III	**Timer- Interrupt and Serial Communication:** General Purpose Timer – External Event Counters: Features – Interfacing Timer and Counter Operation – Interrupts on the ARM 7 – Interrupt Sources – External Interrupt – UART s Features – Serial Communication – RS 232 – RS 485 – USB Hardware – USB Device Software.
Unit – IV	**I^2C- SPI- PWM- Watchdog Timer and Memory Card Interfacing:** I^2C Bus Serial I/O Controller – Interfacing With AT24C1024 – SPI Port Operation – Interfacing with 25LC040 – Pulse Width Modulator – Watchdog Timer – Real Time Clock – SD Memory Card Basics – SPI Memory Card Operation in SPI Mode - LPC 2148 Interfacing with SD Memory Card.
Unit - V	**Interfacing Digital Input and Output:** Interfacing LEDs and Switches – Interfacing Keypads – Interfacing Seven Segment Display – Interfacing LCD – Interfacing Relay- Optocoupler and Buzzer - Interfacing DC Motor – Interfacing Stepper Motor – 10 bit ADC Features Interfacing Temperature Sensor LM35 – 10bit DAC Features - Interfacing DAC – PWM Audio.
Text and Reference Books: ARM Controller: ARM Fundamentals, LPC2148 CPU and Peripherals by A.P. Godse, Technical Publications, 2020 Design- Third Edition-Morgan Kaufmann Publication. J.R.Gibson- ARM Assembly Language- Second Edition- Cengage Learning LPC 214x User Manual, Philips Semiconductor, Volume I, 2005 Raghunandan G. H. , 2015 Microcontroller (ARM) and Embedded Systems, Cengage Learning. Steve Furber -2012- ARM System-on-Chip Architecture- Second Edition- Pearson. Trevor Martin- Hitex ARM7-Based Microcontrollers-The Insider's Guide To The Philips. Warwick A.Smith- ARM Microcontroller Interfacing Hardware and Software- Elektor (www.elecktor.com) Wayne Wolf- Computer as Components: Priciples of Embedded Computing System	
Outcomes	After completion of this course the student should be able to design hardware and develop software in the Keil IDE to design embedded system for various applications.

III - Semester				
Course Code: 23MEL3C2	**Core Course - 8**	T/P	C	H/W
	Mobile Satellite Communication Systems	T	5	6
Objectives	To understand the concepts of mobile communications To understand satellite constellations To understand Radio link modulation coding and multiple access To understand fixed earth stations and satellite broad cast system			

Unit - I	**Introduction to Mobile Telecommunications:** Evolution of Mobile Telecommunications -Terrestrial Systems - Satellite Systems -Satellite System Architecture -Radio Frequency Environment -Orbit -Tolerable Delay in Data Delivery - Handover -Mobility Management -Satellite Access -Spectrum Management -Radio Link Reliability - Mobile Systems -Related Satellite Systems- System Architecture.
Unit - II	**Satellite Constellations:** Satellite Orbits - Orbital Mechanics Basics – Satellite Coverage - Space Environment - Eclipse on Satellites -The Sun's Interference - Doppler Effect - Orbital Debris- Satellite Constellations -Considerations in Constellation Design - Polar Constellations - Inclined Orbit Constellations –Hybrid Constellations - Regional Coverage -Constellations for Non-Real-Time Systems - Use of Spot Beams -Availability Considerations for Non-Geostationary Satellites
Unit - III	**Radio Link- Modulation- Coding and Multiple Access:** General Propagation Characteristics- Land Mobile Channel -Modulation -MSS Requirements - Schemes - Performance Comparison of Conventional Digital Modulation Schemes -Coded Orthogonal Frequency Division Multiplexing (COFDM) Modulation Systems- Spread Spectrum Modulation -Coding -Trellis-Coded Modulation (TCM)-Automatic Repeat Request -Multiple Access Schemes.
Unit – IV	**Fixed Earth Stations- User Terminals- Spacecraft and Standards:** Introduction - Gateways - User Terminals -Antennas - Hand-Held UT -Mobile Terminals - Satellites for MSS -Transponders -Antenna Systems - Effect of Orbital Characteristics on Spacecraft Design –Inter satellite links -Frequency Bands - Launching Satellite Constellations - Satellite Radio Interface Standards - GMR - Satellite Component of UMTS/IMT-2000 -Interactive Mobile Broadband Broadcast Standard - DVB-S2/RCS+M 407.
Unit - V	**Mobile Satellite Broadcast Systems:** Introduction -Mobile Broadcast System Requirements -Service Requirements - Receiver Types -System Configuration - Space Segment-Transmission Technology - OSI Architecture in a Broadcast Context-Prevalent Transmission Systems - Receiver Architecture - DVB-SH System Architecture - Multimedia Broadcast and Multicast Services -DBS Reception on Mobile Terminals.

Text Book

adhavendra Richharia -2014-*Mobile Satellite Communications: Principles and Trends*- 2nd Edition-Wiley.

Reference:

Roger Cochett i-2015- Mobile Satellite Communications Hand Book- 2nd Edition- Wiley Dennis Roddy- 2006- *Satellite Communications*- Mc Graw Hill- 3rd Edition

Outcomes	The students should be able to familiarize with mobile communication Able to analyse and evaluate mobile and satellite communication systems able to familiarize Mobile satellite broadcast system

III - Semester				
Course Code: 23MEL3C3	Core - 9	T/P	C	H/W
	Digital Image Processing	T	4	6
Objectives	To study the image fundamentals and mathematical transforms necessary for image processing. To study the image enhancement techniques To study image Segmentation, representation edge detection and morphological image processing procedures. To study the image compression procedures.			

Unit - I	**Image Processing Basic concept and Terminology:** What is an Image? What is Digital Image? – What is Digital Image Processing – Components of Digital Image Processing System –Digital Image Representation – Binary Images – Gray Level Images – Color Images - Image Acquisition – Image Sensors – Image Digitization – Sampling – Quantization - Neighborhood – Adjacency - Paths – Connectivity – Components - Gray Level Transforma tions - Histogram– Histogram Equalization
Unit - II	**Image Enhancement:** Spatial Domain Filtering Image Smoothing (LPF) – Mean Filter – Gaussian Blur Filter – Image Sharpening (HPF)- Frequency Domain Filtering : Low Pass Filtering – Ideal LPF – Gaussian LPF – Butterworth LPF – High Pass Filtering : Ideal HPF-Gaussian HPF –Butterworth HPF
Unit - III	**Image Segmentation and Representation:** Introduction – Intensity-Based Segmentation – Image Thresholding – Global Thresholding – Optimal Thresholding – Local Thresholding – Region Based Segmentation – Region Growing – Region Splitting and Merging – Watershed Segmentation – Boundary Descriptors – Chain Code, Freeman Code and Shape Number – Signatures – Fourier Descriptors – Histogram Based (Statistical) Features –Texture Features
Unit – IV	**Edge Detection and Morphological Image Processing:** Formulation of the Problem – Basic Concepts – First order Derivative Edge Detection – Second order Derivative Edge Detection – Laplician of Gaussian – The Canny Edge Detector – Edge Linking and Boundary Detection – Morphological Fundamental Concepts and Operations – The Structuring Element – Dilation and Erosion – Compound Operations – Opening – Closing – Morphological Filtering
Unit - V	**Image Compression:** Introduction – Coding Redundancy – Inter-Pixel Redundancy – Image Compression Models – Source Encoder and Decoder – Channel Encoder and Decoder – Information Theory – Classification – Huffman Coding – Lossy Compression Techniques – Threshold Coding – Vector Quantization – Image Compression Standard(JPEG) – Image Compression Using Neural Networks.

Reference Books

Chris Soloman, Toby Breckon, 2019 Fundamentals Digital Image Processing A Practical Approach with Examples in MATLAB, Wiley-Black Well.

Gopi, 2015 Digital Image Processing with MATLAB, Scitech Publications (India) Pvt. Ltd.,

P K Thiruvikraman, 2020 A Course on Digital Image Processing with MATLAB, IOP Publishing Ltd

Rafael C. Gonazalez, Richard E. Woods, 2020 Digital Image Processing Using MATLAB, 3rd Edition, Gatesmark Publishing .

Vipula Singh, 2019 Digital Image Processing with MATLAB & LabVIEW, Cenegate.

Outcomes	Review the fundamental concepts of a digital image processing system. The students should be able to analyze the images using neighborhood and histogram develop the matlab code to design various filters for image enhancement interpret image segmentation and representation techniques develop the matlab code to detect edges in the image using various edge detectors and implement morphological dilation and erosion image processing technique Categorize various compression techniques and Interpret Image compression standards.

III - Semester				
Course Code: 23MEL3P1	**Core Course - 10**	T/P	C	H/W
	Practical - III Embedded system Design with ARM and Digital Image processing	P	4	6
Objectives	➢ To design an embedded hardware and interfacing with ARM ➢ To develop the embedded C codes using keil IDE ➢ To study and learn to programme timer, interrupt, serial communication and other real time interfacing ➢ To develop algorithm to analyses and process the image using MATLAB			

	Interface Traffic Light Controller. 1. Interface Seven Segment Display with ARM 2. Interface LCD with ARM 3. Interface Keypad with ARM 4. Interface Stepper Motor with ARM 5. Interface DC Motor with PWM 6. Interface LM 35 using ADC with ARM 7. Interface DAC to generate Waveforms 8. ARM Timer Programming 9. ARM Counter Programming 10. ARM Interrupt Programming 11. ARM Serial Communication Programming 12. SPI Port Programming 13. Real Time Clock Programming 14. Watchdog Timer Programming 15. Interfacing With AT24C1024 16. PWM Audio 17. Simulation and Display of an Image, Negative of an Image(Binary & Gray Scale) 18. Implementation of Relationships between Pixels 19. Implementation of Transformations of an Image 20. Contrast stretching of a low contrast image, Histogram, and Histogram Equalization 21. Display of bit planes of an Image 22. Display of FFT(1-D & 2-D) of an image 23. Computation of Mean, Standard Deviation, Correlation coefficient of the given Image 24. Implementation of Image Smoothening Filters(Mean and Median filtering of an Image) 25. Implementation of image sharpening filters and Edge Detection using Gradient Filters 26. Image Compression by DCT,DPCM, HUFFMAN coding 27. Implementation of image restoring techniques 28. Implementation of Image Intensity slicing technique for image enhancement 29. Canny edge detection Algorithm
Outcomes	After completion of this lab the student should be able to develop skill to work on keil IDE, design hardware and interface with ARM7 Able to handle and programme timer, interrupt, PWM, UART, I2C, SPI Able to design various filters for image enhancement and able analyze the image using various transformations Able to develop MATLAB code for digital image processing

III - Semester				
Course Code: 23MEL3E1	Discipline Centric Elective – 5 A	T/P	C	H/W
	Internet of Things with Raspberry Pi	T	4	4
Objectives	To understand Smart Objects and IoT Architectures To learn about various IOT-related protocols To build simple IoT Systems using Raspberry Pi To understand data analytics and cloud in the context of IoT To develop IoT infrastructure for popular applications			

Unit - I	**Introduction to IoT**: Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology.
Unit - II	**IoT Architecture**: M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture
Unit - III	**IoT Protocols**: Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BAC Net Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP - Security
Unit – IV	**Sensors and IoT Design Methodology and Basics of Raspberry Pi:** Classification of Sensors - Working Principle of Sensors - Criteria to choose a Sensor -Generation of Sensors- Design methodology- Challenges in IoT Design- IoT System Management - IoT Servers. Raspberry Pi: Terminal Commands - Installation of Libraries on Raspberry Pi - Getting the static IP address of Raspberry Pi - Run a Program on Raspberry Pi
Unit - V	**Interfacing with Raspberry Pi and Connecting to the Cloud:** Interfacing LCD using various protocol – interfacing relay - Play with Digital Sensor - Play with Analog Sensor - Play with Actuators - Pi Camera - Interfacing of camera - Face Recognition using Raspberry Pi- Smart Motion Detector and Upload Image to gmail.com.

Text and Reference Books

sh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain, 2019 "*Internet of Things with Raspberry Pi and Arduino*", First Edition, CRC Press, Taylor and Francis Group.

sh Singh ,Anita Gehlot, Bhupendra Singh, SushabhanChoudhury , 2018 "*Arduino-Based Embedded Systems Interfacing, Simulation, and LabVIEW GUI*", CRC Press, Taylor and Francis Group.

Outcomes	Upon completion of this course, the students should be able to: Analyze various protocols for IoT Develop web services to access/control IoT devices. Design a portable IoT using Rasperry Pi Deploy an IoT application and connect to the cloud. Analyze applications of IoT in real time scenario

III - Semester				
Course Code: 23MEL3E2	Discipline Centric Elective – 5 B	T/P	C	H/W
	Radar Engineering	T	4	4
Objectives	To understand basic of radars and its parameter calculation To understand CW and frequency Modulated Radar transmitters and receivers To understand MTI and pulse Doppler Radar and measure its performance To understand tracking Radar and measure its tracking range To understand different types of receiver and detectors			

Unit - I	Basics of Radar: Introduction- Maximum Unambiguous Range- simple Radar range Equation- Radar Block Diagram and Operation- Radar Frequencies and Applications. Radar Equation : Prediction of Range Performance- Minimum Detectable Signal- Receiver Noise-Modified Radar Range Equation- SNR, Probability of Detection- Probability of False Alarm- Integration of Radar Pulses- Radar Cross Section of Targets (simple targets-sphere, cone-sphere)- Transmitter Power -PRF and Range Ambiguities- System Losses.
Unit - II	CW and Frequency Modulated Radar: Doppler Effect- CW Radar – Block Diagram- Isolation between Transmitter and Receiver- Non-zero IF Receiver- Receiver Bandwidth Requirements- Applications of CW radar- FM-CW Radar: Range and Doppler Measurement- Block Diagram and Characteristics- FMCW altimeter- Multiple Frequency CW Radar.
Unit - III	MTI and Pulse Doppler Radar: Introduction- Principle- MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter- Delay Line Cancellers – Filter Characteristics- Blind Speeds- Double Cancellation- Nth Cancellation Staggered PRFs. Range Gated Doppler Filters- MTI Radar Parameters- Limitations to MTI Performance- MTI versus Pulse Doppler Radar.
Unit – IV	Tracking Radar: Tracking with Radar- Sequential Lobing- Conical Scan- Mono pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two-coordinates)- Phase Comparison Mono pulse- Tracking in Range- Acquisition and Scanning Patterns- Comparison of Trackers.
Unit - V	Radar Receivers –correlation detector- cross correlation receiver -Displays – types. Duplexers – Branch type and Balanced type- Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts- Radiation Pattern- Beam Steering and Beam Width changes,-Series versus parallel feeds- Applications- Advantages and Limitations.

TEXT BOOKS:

G. SasibhushanaRao, *Microwave & Radar Engineering*, Pearson Publications

I. Skolnik,2007, *Introduction to Radar Systems*, TMH Special Indian Edition,2ndEd.,2007.

Peebles, Jr., P.Z., 1998,*Radar Principles*, Wiley, New York.

REFERENCE BOOKS:

GSN Raju, *Radar Engineering*, IK International.

M. Kulkarni, *Microwave & Radar Engineering*, Umesh Publications, 3rd edition

M.I. Skolnik,2005, *Introduction to Radar Systems*, 3rd edition, TMH Ed.

outcomes	Upon completing this study one can able to choose the types of Radar for the particular applications and developed their skill to calculate its parameters and design techniques of transmitters and receivers.

III - Semester				
Course Code: 23MEL3E3	Discipline Centric Elective – 6 B	T/P	C	H/W
	Biomedical Instrumentation	T	4	4
Objectives	To understand the electrodes used to transducer the biosignal To understand how to measure cardiovascular signals To understand X ray computed tomography, Nuclear Imaging system and ultrasonic imaging system To understand biotelemetry.			

Unit - I	ELECTRODES AND TRANSDUCERS: origin of biosignal- Electrode Theory- Bio potential Electrodes- Examples of Electrodes-Basic Transducer Principles - The Transducer and Transduction Principles- Active Transducers, Passive Transducers- Transducers for Biomedical Applications- Pulse Sensors- Respiration Sensor- Transducers with Digital Output.
Unit - II	CARDIOVASCULAR SYSTEM AND MEASUREMENTS: The Heart and Cardiovascular System- Electro Cardiograph- Blood Pressure Measurement- Measurement of Blood Flow and Cardiac Output- Measurement of Heart Sounds- Phonocardiography- The Physiology of The Respiratory System: Tests and Instrumentation for the Mechanics of Breathing, Respiratory Therapy Equipment.
Unit - III	X-Ray Computed Tomography: Properties of X-rays – Photo Electric Effect – Compton Effect – Bremsstrahlung – X –ray tube – X-ray Equipment Block diagram – CT Scanners and Detectors – Image Processing for Computed Tomography – Spiral/helical Computed Tomography – Multislice Spiral Computed Tomography – Clinical Applications of Computed Tomography.
Unit – IV	Nuclear Imaging Systems Instrumentation: The gamma Camera – Image Characteristics – Clinical applications of Nuclear Medicine – Position Emission Tomography – Radio isotops and Radiopharmaceuticals – Radiation Dose.
Unit - V	Ultrasonic Imaging Systems Therapeutic and Diagnostic Equipment – Therapeutic Ultasonic Equipment – Ultrasonic Imaging Equipment – Ultrasonic Waves – Ultrasonic Blood flow Equipment – Obstetrics and Gunecology – Cardiac Disease- The Components of Biotelemetry System- Telemetry for Emergency Patient Monitoring.

Text Book:

ɒtt- A.K. Mathur-2007, *Textbook of Biomedical Instrumentation*- CBS Publishers and Distributors- New Delhi- First Edition.

Books for Reference:

J.Carr-2001, *Introduction to Biomedical Equipment Technology*- Pearson Education- Fourth Edition.

Cromwell-2013 *Biomedical Instrumentation and Measurements*- Prentice Hall of India Pvt. Ltd.- Second Edition.

Khanpur-2003 *Hand Book of Biomedical Instrumentation*- Tata McGraw Hill- Second Edition.

ngata Ram-2000, *Biomedical Electronics and Instrumentation*- Galgotia Publications Pvt. Ltd- First Edition.

Outcomes	The student can able to design a biomedical system and understand the function and applications of various imaging system.

III - Semester				
Course Code: 23MEL3S1	Skill Enhancement Course - 2	T/P	C	H/W
	Research Methodology for Scientific Research	T	2	2

Objectives	To understand perspective of scientific research, principles and identify the good scientific problem To understand planning and designing to approach the scientific research To acquire knowledge for scientific methodology To collect data from the secondary materials, acquire skill to write research paper and importance of conference and workshop To develop their thesis writing skills
Unit – I	**Perspective of scientific Research** Meaning of research – Characteristics of research – Types of research – Importance of research activities – Principles of quality research work – Problems in research – Scientific attitudes – Scientific temper – Quality of the Good researcher – Scientific community – scientific statement – The classical approach – Empiricism – scientific realism.
Unit – II	**Getting started with Research** Introduction – Planning and designing research – criteria for Good research – Guidelines for research skill and awareness – validity of research – Reliability in research – Artifact and Bias – Managerialism and scientific research – Leadership in scientific research
Unit – III	**Scientific methodology** Introduction – Rules and Principles of scientific method – Hypothesis – Testing a Hypothesis – Data collection and analysis – Need for data collections – Methods of data collection – Principles for accessing Research data – Data Processing – Data analysis – Presentation of data – Error analysis - Scientific models.
Unit – IV	**Research in Practice** Literature review – Journals – Conference Proceedings – Journal impact factor (JIF) – Citation Index – h index – g index – hg index – Reading a scientific paper –seminar conference and workshops
Unit – V	**Thesis Writing** The Format of Thesis – Chapter and Page formats – Tables of Data – Figures – Footnotes – Bibliography – End Matters – Common Error in Scientific writing – Editing and Proof reading of a Thesis – Reasons for Rejection of the Thesis.

References

1. K. Prathapan, Research Methodology for Scientific Research, Dreamtech Press, and I K International publishing House Pvt. Ltd. New Delhi, 2019.
2. R. Gopalan, Thesis writing, Vijay Nicole Imprints Private Limited, Chennai 2009.
3. C. R. Kothari, Research Methodology methods and techniques, New Age International Publishers, Fourth Edition, 2019.
4. P. Ramadoss, Research and writing across the disciplines, MJP Publishers, Chennai, 2009

Outcomes	Upon completing this course, the student get research attitude and become a good and quality scientific researcher. The student attained skill to write research papers, presentation techniques at the conference and workshop and also gained knowledge to organize the seminar, conference and workshop. Finally the student get precocious thesis writing skill and project report writing skill

IV – Semester				
Course Code: 23MEL4C1	**Core Course- 11**	T/P	C	H/W
	Nanoelectronics	T	5	6
Objectives	To understand the Quntum mechanics fundamentals required to acquire knowledge on nanoelectronics To know, understand and need of transition from micro to nano To understand nanomaterials and its fabrication techniques in nanoscale To understand and study the electron transition in nanoelectronic devices, operations and its characteristics			
Unit – I	**Quantum Mechanics of Electronics:** Introduction to Nano Electronics – Top –Down Approach – Bottom – Up approach General postulates of Quantum Mechanics – Operators for Quantum Mechanics – Eigen values and Eigen functions – Hermitian Operators –Time Independent Schrodinger's Equation – Electrons in a Potential Well			

Unit – II	**Materials for Nanoelectronics:** Semiconductors – Crystal Lattices – Bonding in Crystals – Electron Energy Bands – Direct Band Gap and Indirect Band Gap Semiconductors – Band Structure of Semiconductor Alloys – Semiconductor Hetrostructure – Organic Semiconductors –Carbon Nanomaterials.
Unit – III	**Growth- and Fabrication for Nanostructures:** Bulk Crystal and Hetrostructure Growth – Single Crystal Growth – Epitaxial Growth – Molecular Beam Epitaxy – Clusters and Nanocrystals – Methods of Nanotube Growth – Arc-Discharge and Laser Ablation – Chemical Vapor Deposition – Directed Growth of Single Walled Nanotube – Self Assembly of Nanostructures
Unit – IV	**Electron transport in Semiconductors:** Time and Length Scales of the electrons in solids – Statistics of the electron in solids and Nanostructres – The Density of States of Electrons in Nanostructure – Electron transport in Nanostructres – Electrons in Quantum Well – Electrons in Quantum Wires – Electrons in Quantum Dots.
Unit – V	**Nanoelectronic Devices:** Resonant-tunneling Diodes – Field-effect Transistor – Single Electron Transistor – Potential-effect Transistor – LEDs and Lasers – Quantum-dot Cellular Automata – Nanoelectromechanical System Devices.

Reference Books

Anupama B. Kaul, 2013 Microelectronics to Nanoelectronics Materials, Devices & Manufacturability, CRC Press, Taylor & Francis Group, 1st Edition.

Daniel Bes, 2012 Edition Quantum Mechanics: A Modern and Concise Introductory Course (Graduate Texts in Physics) , Springer, 3rd ed.

Georage W. Hanson-2008- Fundamentals of Nanoelectronics- Pearson Education. Hassan Raza, 2019 Nanoelectronics Fundamentals Materials, Devices and Systems, Springer.

Kamal Singh, S.P.Singh, 2016 Elements of Quantum Mechanics, S.Chand & Company Pvt. Ltd., KAR A, 2017 Nanoelectronics And Materials Development, INTECH Edition. Loutfy H. Madkour, 2019 Nanoelectronic Materials: Fundamentals and Applications, Springer (Advanced Structured Materials Book 116) 1st ed.

Loutfy H. Madkour, 2019, Nanoelectronic Materials Fundamentals and Applications, Springer, ISBN 978-3-030-21621-4 (eBook), https://doi.org/10.1007/978-3-030- 21621-4

Robert Puers, Livio Baldi, Marcel Van de Voorde , Sebastiaan E. van Nooten, – 3 May 2017 Nanoelectronics: Materials, Devices, Applications, 2 Volumes (Applications of Nanotechnology) Hardcover

Valdimir V.Mitin- Viatcheslav A. Kochelap and Michal A. Stroscio– 2008- *Introduction to Nanoelectronics*- Cambridge University Press.

Outcomes	Able to know the importance of nanoelectronics in future After completing this course the students will be motivated to involve in research

IV – Semester				
Course Code: 23MEL4C2	**Core Course – 12**	T/P	C	H/W
	Wireless Communication Systems	T	5	6

Objectives	To understand various wireless communication systems working and its applications To understand cellular concept and system design fundamentals To understand mobile radio propagation large and small scale To understand multiple access techniques for wireless communications
Unit - I	**Introduction to Wireless Communication Systems:** Evolution of Mobile Radio Communications – Paging Systems – Cordless Telephone Systems – Cellular Telephone Systems - Comparison of Common Wireless Communication Systems – Trends in Cellular Radio and Personal Communications – 2G Cellular Networks – 3G Wireless Network – Wireless Local Loop and LMDS – WLANs – Blue Tooth – PANs.
Unit - II	**Cellular Concept and System Design Fundamentals:** Frequency Reuse – Channel Assignment Strategies – Hand off Strategies – Interference and System Capacity – Trunking and Grade of Service – Improving Coverage and Capacity in Cellular Systems.

Unit - III	**Mobile Radio Propagation: Large Scale Path Loss:** The Three Basic Propagation Mechanisms – Reflection – Ground Reflection Model – Diffraction – Scattering – Practical Link Budget Design uses Path Loss Model – Outdoor Propagation Models – Indoor Propagation Models. Signal Penetration into Building – Ray Tracing and Site Specific Modeling.
Unit – IV	**Mobile Radio Propagation: Small-Scale Fading and Multipath:** Small Scale Multipath Propagation – Impulse Response Model of Multipath Channel – Small Scale Multipath Measurement – Parameters of Mobile Multipath Chanels – Types of Small Scale Fading – Fading Effects Due to Doppler Spread – Rayleigh and Ricean Distributions – Statistical Models for Multipath Fading Channel – Theory of Multipath Shape Factors for Small – Scale Fading Wireless Channels.
Unit - V	**Multiple Access Techniques for Wireless Communications:** Introduction to Multiple Access – FDMA – TDMA – Spread Spectrum Multiple Access – FHMA – CDMA – Hybrid Spread Spectrum Techniques – Packet Radio – Pure ALOHA – Slotted ALOHA – CSMA – Reservation Protocols – Reservation ALOHA – PRMA – Capture Effect in Packet Radio – Capacity of Cellular Systems – Capacity of Cellular CDMA – Capacity of CDMA with Multiple Cells – Capacity of Space Division Multiple Access.

Text Books:

K.Feher-1995-Wireless digital communications-PHI-New Delhi

Theodore S. Rappaport– 2010- Wireless Communications Principles and Practice- Pearson Education.

William C.Y. Lee-2012- Mobile Communications Engineering Theory and Applications- McGraw-Hill- Second Edition.

Books for Reference:

David Tse and Pramod Viswanath- 2005- Fundamentals of Wireless Communication- Cambridge University Press

Dharma Prakash Agrawal and Qing-An Zeng– 2012 - Introduction to Wireless and Mobile Systems- Cengage Learning- Third Edition

Edited by Jack M. Holtzman and David J. Goodman.- 1994-Wireless and Mobile Communications- Allied Publishers Ltd.

Schiller.-2000-Mobile Communications;Pearson Education Asia Ltd

Simon Haykin - Michael Moher adopted by David Koilpillai- 2011- Modern Wireless Communications- Pearson Education.

William C.Y.Lee– 2012- Mobile Cellular Telecommunications Analog and Digital Systems- Tata McGraw-Hill- Second Edition

Outcomes	The student should be Able to design cellular mobile radio communication system

IV - Semester				
Course Code: 23MEL4PR	**Core Course - 13**	T/P	C	H/W
	Project with viva voce		6	10
Objectives	To get resources, learn new techniques from experts and get industrial exposure To understand research methodology and report preparation			
Outcomes	Able to involve in research, entrepreneur and get employability in hardware and software industries.			

IV - Semester				
Course Code: 23MEL4E1	Discipline Centric Elective – 6 A	T/P	C	H/W
	Biomedical Signal and Image Processing	T	4	4
Objectives	To study wavelet transformation To understand ECG signal processing using various algorithms step by step To understand EEG signal processing using various algorithms step by step To understand Brain CT- image processing and develop various algorithms to detect the brain tumor To understand MRI image processing and develop various algorithms to detect the features To understand finger print imageprocessing to develop finger print biometric system			
Unit - I	**ECG Signal Processing:** Origin of ECG Signal – ECG Electrode Placement – Modeling and Representation of ECG – Heart Rate – Processing and Feature Extraction of ECG: Time Domain Analysis – Frequency Domain Analysis – Wavelet Domain Analysis.			
Unit - II	**EEG Signal Processing :** The Brain Wave – Characteristics of EEG Signal – Basic Principle of EEG Signal Analysis - Brain Computer Interface (BCI) EEG signal Processing System Block Diagram - EEG signal Acquisition – Signal Preprocessing using Adaptive Filtering - Signal Extraction using FFT and Wavelet Transformation.			
Unit - III	**Brain CT-scan image processing:** CT Scanner and Detector - Pre- Processing using Image Restoration – Edge Detection Using Canny and Prewitt Methods – Gobar Filter to Detect Region of Interest – Detect the Features Using BLOB (binary large object) Analysis.			

Unit – IV	**MRI Image Processing:** Preprocessing using Gaussian Filter – Image Enhancement using Threshold Based Anisotropic Diffusion Filter - Threshold model on bounding box method - Parameters used to define a bounding box - Threshold with bounding box approach to detect tumor – Image Segmentation - Morphological Dilation and Erosion.
Unit - V	**Fingerprint Biometrics:** Finger Print Sensors – Useful Features of the Fingerprint - Fingerprint Recognition Systems – Histogram Equalization – Fingerprint Image Enhancement Using Fourier Transform – Binarization – Image Segmentation - Minutiae Extraction – Finger Print Indexing – Advantages and Disadvantages.

Reference Books and Journals

A.Mohanarathinam," Enhanced Image Filtration using Threshold based Anisotropic Filter for Brain Tumor Image Segmentation ",Proceedings of the Third International Conference on Intelligent Sustainable Systems [ICISS 2020] IEEE Xplore Part Number: CFP20M19-ART; ISBN: 978-1-7281-7089-3

G.R. Sinha- Sandeep B. Patil - 2013- Biometrics: Concepts and Applications- Wiley

Joni-Kristian Kamarainen, "Gabor Features in Image Analysis", Machine Vision and Pattern Recognition Laboratory, Lappeenranta University of Technology (LUT Kouvola

Kayvan Najarian and Robert Splinter , 2012, Biomedical Signal and Image Processing, CRC Press, Taylor & Francis Group, http://taylorandfrancis.com Learning, Sixth Indian.

Nilesh Bhaskarrao Bahadure, Arun Kumar Ray and Har Pal Thethi, "Image Analysis for MRI Based Brain Tumor Detection and Feature Extraction Using Biologically Inspired BWT and SVM", International Journal of Biomedical Imaging, Volume 2017, Article ID 9749108, 12 pages, https://doi.org/10.1155/2017/9749108

Rupavathy. Na , and Dr. M. J. Carmel Mary Belindab," Anisotrophic Filter Based Detection of Brain Tumor ",Turkish Journal of Computer and Mathematics Education Vol.12 No.9 (2021), 172-181.

Sonka, Hlavac and Boyle, Reprint 2011 " Digital Image Processing and Computer Vision", CENGAGE

Outcomes	The student should be able to develop algorithm to design an ECG arrhythmia detection system able to develop algorithm to design an EEG diseases detection system able to develop algorithm to detect brain tumor able to develop algorithm to design fingerprint biometric system

IV - Semester				
Course Code: 23MEL4S1	Skill Enhancement Course - 3	T/P	C	H/W
	Biomedical Sensors	T	2	4

Objectives	To understand the definition and classification of biomedical sensors To understand different physical sensors and its measurements techniques To understand Chemical sensor and its measurement techniques To understand digital transducers and image sensors for image processing and computer vision applications To understand concept and application of MEMS
Unit - I	**Definition and Classification of Biomedical Sensors** Basic Concept of Sensors - Classification of Biomedical Sensors - Biomedical Measurement Technology - Characteristics of Biomedical Sensors and Measurement - Sensor Characteristics and Terminology - Biocompatibility Design of Sensors – Micro fabrication of Biomedical Sensors.
Unit - II	**Physical Sensors and Measurement** Resistance Sensors and Measurement - Inductive Sensors and Measurement - Capacitive Sensors and Measurement - Piezoelectric Sensors and Measurement - Magnetoelectric Sensors and Measurement - Photoelectric Sensors and its applications - Thermoelectric Sensors and Measurement
Unit - III	**Chemical Sensors and Measurement** Definition and Principle - Classification and Characteristics - Ion Sensors - Gas Sensors - Humidity Sensors - Intelligent Chemical Sensor Arrays - Sensor Networks

Unit - IV	**Digital Transducers** Innovative sensor technology - Advantages of Digital Transducers - Incremental Optical Encoder and Hardware Features - Direction, Position, and Speed Sensing - Resolution and Error Considerations - Absolute Optical Encoder - Linear Encoder - Digital Binary Sensors - Digital Resolver, Tachometer - Hall-Effect Sensors – Image sensors (Digital Camera and Image Acquisition)
Unit - V	**Microelectromechanical System (MEMS) Sensors** MEMS Characteristics and Modeling - MEMS Materials and Fabrication - Wireless Sensor Network (WSN) Architecture - Advantages and Applications of WSN - Energy Management in WSN- Nature and Types of Multisensor Data Fusion-Kalman Filter Approach to Sensor Fusion - Fuzzy-Neural Network Approach to Sensor Fusion

Referencces

1. Ping Wang and Qingjun Liu, Biomedical Sensors and Measurement, Zhejiang University Press, Springer, 2011
2. Clarence W de Silva, Sensor Systems Fundamentals and Applications, CRC Press, New York 2017.

Out comes	Skill developed to design a biomedical system using physical and chemical sensors Skill developed to design image processing and computer vision system Skill developed to fabricate MEMS devices