S.No	Course Code	Course Name	L	T	P	Credits

S.No	Course Code	Course Name	L	T	P	Credits
1.	20A04601T	Antennas & Microwave Engineering	3	0	0	3
2.	20A04602T	VLSI Design	3	0	0	3
3.	20A04603T	Communication Networks	3	0	0	3
4.	20A04604a 20A04604b 20A04604c	**Professional Elective Course– II** Electronic Measurements and Instrumentation Embedded System Design Optical Communications	3	0	0	3
5.		**Open Elective – II**	3	0	0	3
6.	20A04601P	Antennas & Microwave Engineering Lab	0	0	3	1.5
7.	20A04602P	VLSI Design Lab	0	0	3	1.5
8.	20A04603P	Communication Networks Lab	0	0	3	1.5
9.	20A04607	**Skill oriented course - IV** RF System Design	1	0	2	2
10.	20A99601	**Mandatory Non-credit Course** Intellectual Property Rights & Patents	2	0	0	0
		Total				**21.5**
		Industry Internship (Mandatory) for 6 - 8 weeks duration during summer vacation				

The table above is titled **Semester–VI**.

Open Elective Course – II

S.No.	CourseCode	Course Name	Offered by the Dept.
1	20A01605	Environmental Economics	CE
2	20A02605	Smart Electric Grid	EEE
3	20A03605	Introduction to Robotics	ME
4	20A05605a	Principles of Operating Systems	CSE & Allied/IT
5	20A05605b	Foundations of Machine Learning	
6	20A05605c	DataAnalytics Using R	
7	20A27605	Food Refrigeration and Cold Chain Management	FT
8	20A54701	Wavelet Transforms & its applications	Mathematics
9	20A56701	Physics Of Electronic Materials and Devices	Physics
10	20A51701	Chemistry of Polymers and its Applications	Chemistry

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem	L	T	P	C
	3	0	0	3

(20A04601T)ANTENNAS&MICROWAVE ENGINEERING

Course Objectives:
- To enable the student to understand the basic principles in antenna and microwave system design
- To make the student to acquire knowledge in the area of various antenna designs.
- To enhance the student knowledge in the area of microwave components and antenna for practical applications.

Course Outcomes: At the end of this course, the students will be able to
- Learn about the antenna's basics and wire antennas.
- Gain knowledge on few types of antennas, their operation and applications.
- Understand the uses of antenna arrays and analyze waveguides and resonators
- Analyze various microwave components and understand the principles of different microwave sources.
- Gain knowledge on microwave semiconductor devices and microwave measurements.

UNIT I
Antenna Basics &Wire Antennas: Definition of antenna, Radiation Mechanism – single wire, two wire, dipoles, Antenna Parameters - Radiation Patterns, Main Lobe and Side Lobes, Beam widths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Aperture Efficiency, Effective Height and length, Radiation from Small Electric Dipole, Quarter wave Monopole and Half wave Dipole – Current Distributions, Field Components, Radiated power, Radiation Resistance, Loop Antennas - Introduction, Small Loop, Comparison of far fields of small loop and short dipole, Radiation Resistances and Directives of small and large loops (Qualitative Treatment), Arrays with Parasitic Elements - Yagi - Uda Arrays, Folded Dipoles & their characteristics

UNIT II
VHF, UHF and Microwave Antennas: Helical Antennas-Helical Geometry, Helix modes, Horn Antennas- Types, Fermat's Principle, Optimum Horns, Design considerations of Pyramidal Horns, Micro strip Antennas- Introduction, features, advantages and limitations, Rectangular patch antennas-Geometry and parameters, characteristics of Micro strip antennas, reflector antennas - Introduction, corner reflectors, parabola reflectors- geometry, pattern characteristics, Feed Methods, Reflector Types - Related Features, Lens Antennas - Geometry of Non-metallic Dielectric Lenses, Zoning , Tolerances, Applications

UNIT III
Antenna Arrays and propagation: Arrays of 2 Isotropic sources- Different cases, Principle of Pattern Multiplication, Uniform Linear Arrays – Broadside Arrays, End fire Arrays, EFA with Increased Directivity, Derivation of their characteristics and comparison, Bionomial Arrays, Different modes of wave propagation, Ground wave propagation Space wave propagation - Sky wave propagation **(Qualitative treatment).**

Waveguides: Introduction, Rectangular waveguides, Field expressions for TE and TM modes, Wave propagation in the guide, Phase and group velocities, Power transmission and attenuation, Waveguide current and mode excitation, Circular waveguide – TE and TM modes, Wave propagation, waveguide resonators.

UNIT IV
Passive Microwave Devices: Introduction to scattering parameters and their properties, Terminations, Variable short circuit, Attenuators, Phase shifters, Hybrid Tees (H-plane, E-plane, Magic Tees), Hybrid ring, Directional Couplers – Bethe hole and Two hole Couplers, Microwave propagation in Ferrites, Microwave devices employing Faraday rotation – Isolator, Circulator, Deriving Scattering matrix for Microwave passive devices.

Microwave Amplifiers and Oscillators: Microwave Tubes: Linear Beam Tubes – Two cavity Klystron amplifier -velocity modulation, bunching process, output power, Reflex Klystron oscillator, power output and efficiency, Travelling Wave Tube (TWT) – Bunching process and amplification

process (**Qualitative treatment only**). Crossed Field Tubes – Magnetron oscillator, pi-mode operation, power output and efficiency, Hartree Condition.

UNIT V
Microwave Semiconductor Devices: Gunn Oscillator – Principle of operation, Characteristics, Two valley model, IMPATT, TRAPATT diodes.
Antennas and Microwave Measurements: Sources of errors, Patterns to be Measured, Pattern Measurement Arrangement, Directivity Measurement, Gain Measurements (by comparison, Absolute and 3-Antenna Methods). Description of Microwave bench-different blocks and their features, errors and precautions, Microwave power measurements, Measurement of attenuation, frequency, VSWR (low, medium, high), Measurement of 'Q' of a cavity, Impedance measurements.

Textbooks:
1. John D. Kraus, Ronald J. Marhefka and Ahmad S.Khan, "Antennas and Wave propagation", TMH, New Delhi, 4th Ed., 2010.
2. Samuel Y. Liao, "Microwave devices and circuits", 3rd Edition, Pearson Publishing, 2003.

References:
1. R. E. Collin, "Foundations for microwave engineering", 2nd Edition, John Wiley, 2002.
2. C.A. Balanis, "Antenna Theory- Analysis and Design", John Wiley & Sons, 2nd Edn., 2001.
3. M. Kulkarni, "Microwave and Radar Engineering", Umesh Publications, 4th edition 2009.
4. G.S.N Raju, "Antenna and Wave Propagation", Pearson Education India, 3rd Edition 2009.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem	L	T	P	C
	3	0	0	3

(20A04602T)VLSI DESIGN

Course Objectives:
- To give exposure to different steps involved in fabrication of ICs using MOS transistor, CMOS/BICOM transistors and passive components.
- To provide knowledge on electrical properties of MOS &BICMOS devices to analyze the behavior of inverters designed with various loads.
- To provide concepts to design building blocks of data path of any system using gates.
- To teach about basic programmable logic devices and testing of CMOS circuits.

Course Outcomes:
- Acquire qualitative knowledge about the fabrication process of integrated circuit using MOS transistors,
- Draw the layout of any logic circuit which helps to understand and estimate parasitic of any logic circuit
- Design building blocks of data path using gates.
- Design simple memories using MOS transistors and can understand design of large memories
- Understand the concept of testing and adding extra hardware to improve testability of system

UNIT I
Introduction: Brief Introduction to IC technology MOS, PMOS, NMOS, CMOS &BiCMOS Technologies Basic Electrical Properties of MOS and BiCMOS Circuits: I_{DS} - V_{DS} relationships, MOS transistor Threshold Voltage-V_T, figure of merit-ω_0, Transconductance - g_m, g_{ds} ; Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, Bi-CMOS Inverters.

UNIT II
VLSI Circuit Design Processes: VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, Lambda(λ)-based design rules for wires, contacts and Transistors, Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling.

UNIT III
Gate level Design: Logic gates and other complex gates, Switch logic, Alternate gate circuits. Basic Circuit Concepts: Sheet Resistance Rs and its concepts to MOS, Area Capacitances calculations, Inverter Delays, Driving large Capacitive Loads, Wiring Capacitances, Fan-in and fan-out

UNIT IV
Subsystem Design: Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators, Counters. VLSI Design styles: Full-custom, Standard Cells, Gate-arrays, FPGAs, CPLDs and Design Approach for Full-custom and Semi-custom devices, parameters influencing low power design.

UNIT V
CMOS Testing: Need for testing, Design for testability - built in self-test (BIST) – testing combinational logic –testing sequential logic – practical design for test guide lines – scan design techniques.

Textbooks:
1. Essentials of VLSI Circuits and Systems, Kamran Eshraghian, EshraghianDougles, A. Pucknell, 2005, PHI.
2. Modern VLSI Design – Wayne Wolf, 3 Ed., 1997, Pearson Education.

References:
1. CMOS VLSI Design-A Circuits and Systems Perspective, Neil H.E Weste, David Harris, Ayan Banerjee, 3rd Edn, Pearson, 2009.
2. BehzadRazavi , "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2003.
3. Jan M. Rabaey, "Digital Integrated Circuits", AnanthaChandrakasan and Borivoje Nikolic, Prentice-Hall of India Pvt.Ltd, 2nd edition, 2009.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem	L	T	P	C
	3	0	0	3

(20A04603T) DATA COMMUNICATION &NETWORKS

Course Objectives:
To provide a solid conceptual understanding of the fundamentals of data communications and computer networks.

Course Outcomes:
- Understand the basics of data communication, networking, internet and their importance.
- Analyze the services and features of various protocol layers in data networks.
- Differentiate wired and wireless computer networks
- Analyse TCP/IP and their protocols.
- Recognize the different internet devices and their functions.

UNIT I

Data Communications: Components, protocols and standards, Network and Protocol Architecture, Reference Model ISO-OSI, TCP/IP-Overview, topology, transmission mode, digital signals, digital to digital encoding, digital data transmission, DTE-DCE interface, interface standards, modems, cable modem, transmission media guided and unguided, transmission impairment, Performance, wavelength and Shannon capacity. Review of Error Detection and Correction codes. Switching: Circuit switching (space-division, time division and space-time division), packet switching (virtual circuit and Datagram approach), message switching.

UNITII

Data Link Layer: Design issues, Data Link Control and Protocols: Flow and Error Control, Stop-and-waitARQ. Sliding window protocol, Go-Back-N ARQ, Selective Repeat ARQ, HDLC, Point-to – Point Access: PPPPoint –to- Point Protocol, PPP Stack

UNIT III

Medium Access Sub layer: Channel allocation problem, Controlled Access, Channelization, multiple access protocols, IEEE standard 802.3 & 802.11 for LANS and WLAN, high-speed LANs, Token ring, Token Bus, FDDI based LAN, Network Devices-repeaters, hubs, switches bridges.

UNITIV

Network Layer: Design issues, Routing algorithms, Congestion control algorithms, Host to Host Delivery: Internetworking, addressing and routing, IP addressing (class full & Classless), Subnet, Network Layer Protocols: ARP, IPV4, ICMP, IPV6 ad ICMPV6.

UNIT V

Transport Layer: Process to Process Delivery: UDP; TCP, congestion control and Quality of service. Application Layer: Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail(SMTP), file transfer (FTP), HTTP and WWW.

Textbooks:
1. S. Tannenbum, D. Wetherall, ―Computer Networks‖, Prentice Hall, Pearson, 5thEd
2. Behrouz A. Forouzan, ―Data Communications and Networking‖, Tata McGraw-Hill, 4th Ed

References:
1. Fred Halsall, ―Computer Networks‖, Addison – Wesley Pub. Co. 1996.
2. Larry L, Peterson and Bruce S. Davie, ―Computer Networks: A system Approach‖, Elsevier, 4thEd
3. Tomasi, ―Introduction To Data Communications & Networking‖, Pearson 7th impression 2011
4. William Stallings, ―Data and Computer Communications‖, Prentice Hall, Imprint of Pearson, 9thEd.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem	L T P C
	3 0 0 3

(20A04604a) ELECTRONIC MEASUREMENTS AND INSTRUMENTATION
(Professional Elective Course- II)

Course Objectives:
The objective of the course is to introduce the fundamentals of Electronics Instruments and Measurement providing an in-depth understanding of Measurement errors, Bridge measurements, Digital Storage Oscilloscope, Function Generator and Analyzer, Display devices, Data acquisition systems and transducers.

Course Outcomes:
- Explain operation of various instruments required in measurements
- Apply measurement techniques for different types of tests
- Select specific instruments for specific measurement function
- Use oscilloscope to determine frequency and phase of a sinusoidal signal
- Compare different types of bridge circuits
- Analyze various measuring techniques for both electrical and nonelectrical quantities

UNIT 1
Performance characteristics of Instruments: Static characteristics, Accuracy, Precision, Resolution, Sensitivity, static and dynamic calibration, Errors in Measurement, and their statistical analysis, dynamic characteristics-speed of Response, fidelity, Lag and dynamic error. DC ammeters, DC voltmeters, AC voltmeters Thermocouple type RF ammeter, ohm meters, series type, shunt type, multi meter for voltage, current and resistance measurements.

UNIT II
Oscilloscopes: Standard specifications of CRO,CRT features, vertical and horizontal amplifiers, horizontal and vertical deflection systems, sweep trigger pulse, delay line, sync selector circuits, probes for CRO – active, passive, and attenuator type, dual trace/beam CRO, Principles of sampling oscilloscope, storage oscilloscope, and digital storage oscilloscope, Digital frequency counters, time & Period measurements.

UNIT III
Signal Generators and Analyzers: Fixed and variable frequency AF oscillators, function generators, pulse, random noise, sweep, and arbitrary waveform generators, their standards, specifications and principles of working (Block diagram approach); Wave analyzers, Harmonic distortion analyzers, Spectrum analyzers, and Logic analyzers.

UNIT IV
Bridges: Wheatstone bridge, We in Bridge, errors and precautions in using bridges, AC bridges: Measurement of inductance-Maxwell's bridge, Anderson Bridge. Measurement of capacitance-Schearing Bridge, Kelvin Bridge, Q-meter, EMI and EMC, Interference and noise reduction techniques.

UNIT V
Sensors and Transducers: Active and passive transducers: Measurement of displacement (Resistance, capacitance, inductance; LVDT) Force (strain gauges) Pressure (piezoelectric transducers) Temperature (resistance thermometers, thermocouples, and thermistors), Velocity, Acceleration, Vibration, pH measurement.

Textbooks:
1. H.S.Kalsi, Electronic Instrumentation, 3rdedition, McGraw Hill Education, 2017.

References:
1. D. Helfrick, W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, ,1st edition, Pearson Education India, 2015
2. David A. Bell, Electronic Instrumentation and Measurements, Oxford Univ. Press, 2007
3. B.M. Oliver, J.M. Cage, Electronic Measurements and Instrumentation, TMH Reprint 2009.
4. Ernest O. Doebelin and Dhanesh N Manik, Measurement Systems, 6th Ed., TMH,2010.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem	L	T	P	C
	3	0	0	3

(20A04604b) EMBEDDED SYSTEM DESIGN
(Professional Elective Course- II)

Course Objectives:
- To teach the basics of an embedded system and RTOS.
- To introduce the typical components of an embedded system & different communication interfaces.
- To provide knowledge on the design process of embedded system applications

Course Outcomes:
- Identify hardware and software components of an embedded system
- Learn the basics of OS and RTOS
- Illustrate different Inter Process Communication (IPC) mechanisms used by tasks/process/tasks to communicate in multitasking environment
- Design simple embedded system-based applications

UNITI INTRODUCTION TO EMBEDDED SYSTEMS
History of embedded systems, Classification of embedded systems based on generation and complexity, Purpose of embedded systems, The embedded system design process-requirements, specification, architecture design, designing hardware and software, components, system integration, Applications of embedded systems, and characteristics of embedded systems.

UNITII TYPICAL EMBEDDED SYSTEM
Core of the embedded system-general purpose and domain specific processors, ASICs, PLDs, COTs; Memory-ROM, RAM, memory according to the type of interface, memory shadowing, memory selection for embedded systems, Sensors, actuators, I/O components: seven segment LED, relay, piezo buzzer, push button switch, other sub-systems: reset circuit, brownout protection circuit, oscillator circuit real time clock, watch dog timer.

UNITIII COMMUNICATION INTERFACE
Onboard communication interfaces-I2C, SPI, CAN, parallel interface; External communication interfaces-RS232 and RS485, USB, infrared, Bluetooth, Wi-Fi, ZigBee, GPRS, GSM.

UNITIV EMBEDDED FIRMWARE DESIGN AND DEVELOPMENT
Embedded firmware design approaches-super loop based approach, operating system based approach; embedded firmware development languages-assembly language based development, high level language based development.

UNITV RTOS BASED EMBEDDED SYSTEM DESIGN
Operating system basics, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling: non-pre-emptive and pre-emptive scheduling; task communication-shared memory, message passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques

Textbooks:
1. Introduction to Embedded Systems - Shibu KV, Mc Graw Hill Education.
2. Computers as Components –Wayne Wolf, Morgan Kaufmann (second edition).

References:
1. Embedded System Design -frank vahid, tony grivargis, john Wiley.
2. Embedded Systems- An integrated approach - Lyla b das, Pearson education 2012.
3. Embedded Systems – Raj Kamal, TMH

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem   L T P C
                                                                      3 0 0 3

(20A04604c) OPTICAL COMMUNICATIONS
(Professional Elective Course- II)

Course Objectives:
- To understand the construction and characteristics of optical fibre cable.
- To develop the knowledge of optical signal sources and power launching.
- To identify and understand the operation of various optical detectors.
- To understand the design of optical systems and WDM.

Course Outcomes:

At the end of the course, the student will be able to:
- Understand and analyze the constructional parameters of optical fibres.
- Estimate the losses due to attenuation, absorption, scattering and bending.
- Compare various optical detectors and choose suitable one for different applications.

UNIT I

Overview of Optical Fiber Communication: - Historical development, The general system, Advantages of Optical Fiber Communications, Optical Fiber Wave Guides- Introduction, 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, Effective Refractive Index, Fiber Materials Glass, Halide, Active Glass, Chalgenide Glass, Plastic Optical Fibers.

UNIT II

Signal Distortion in Optical Fibers: Attenuation, Absorption, Scattering and Bending Losses, Core and Cladding Losses, Information Capacity Determination, Group Delay, Types of Dispersion - Material Dispersion, Wave-Guide Dispersion, Polarization Mode Dispersion, Intermodal Dispersion, Pulse Broadening, Optical Fiber Connectors- Connector Types, Single Mode Fiber Connectors, Connector Return Loss.

UNIT III

Fiber Splicing: Splicing Techniques, Splicing Single Mode Fibers, Fiber Alignment and Joint Loss- Multimode Fiber Joints, Single Mode Fiber Joints. Optical Sources- LEDs, Structures, Materials, Quantum Efficiency, Power, Modulation, Power Bandwidth Product, Injection Laser Diodes- Modes, Threshold Conditions, External Quantum Efficiency, Laser Diode Rate Equations, Resonant Frequencies, Reliability of LED & ILD.

UNIT IV

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 V

Optical System Design: Considerations, Component Choice, Multiplexing, Point-to- Point Links, System Considerations, Link Power Budget with Examples, Overall Fiber Dispersion in Multi-Mode and Single Mode Fibers, Rise Time Budget with Examples. Transmission Distance, Line Coding in Optical Links, WDM, Necessity, Principles, Types of WDM, Measurement of Attenuation and Dispersion, Eye Pattern.

Textbooks:

1. Optical Fiber Communications – Gerd Keiser, MC GRAW HILL EDUCATION, 4th Edition, 2008.
2. Optical Fiber Communications – John M. Senior, Pearson Education, 3rd Edition, 2009.

References:

1. Fiber Optic Communications – D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education, 2005.
2. Text Book on Optical Fibre Communication and its Applications – S.C.Gupta, PHI, 2005.
3. Fiber Optic Communication Systems – Govind P. Agarwal , John Wiley, 3rd Ediition, 2004.
4. Introduction to Fiber Optics by Donald J.Sterling Jr. – Cengage learning, 2004.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem	L	T	P	C
	0	0	3	1.5

(20A04601P) ANTENNAS &MICROWAVE ENGINEERING LAB

Course Objectives:
- To understand the working, different microwave components and verify characteristics using microwave bench setup.
- To study various antennas

Course Outcomes:

At the end of this course, the students will be able to
- Understand the working, different microwave components and sources in a microwave bench
- Verify the characteristics of various microwave components using microwave bench setup
- Design and study of various antennas
- Analyze performance characteristics of Antennas

Part-A Antennas Lab

1. To analyze the characteristics of Simple Dipole $\lambda/2$ and $\lambda/4$ Antenna
2. To analyze the variation in the Radiation Strength at given distance from Antenna
3. To analyze the Reciprocity Theorem for Antennas
4. To study Folded Dipole $\lambda/2$ Antenna
5. Study of Yagi Uda 3 element Folded Dipole, 5 element folded dipole.
6. To analyze the characteristics of micro strip antennas
7. To analyze the characteristics and radiation pattern of broad side and end fire arrays.

Part-B Microwave Engineering lab

1. Reflex Klystron Characteristics.
2. Gunn Diode Characteristics.
3. Directional Coupler Characteristics.
4. VSWR Measurement.
5. Measurement of Wave Guide Parameters.
6. Measurement of Impedance of a given load.
7. Measurement of Scattering Parameters of a Magic Tee.
8. Measurement of Scattering Parameters of a Circulator.
9. Attenuation Measurement.
10. Microwave Frequency Measurement

NOTE: At least 5 Experiments from each section must be done in the semester.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem   **L T P C**

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(20A04602P) VLSI DESIGN LAB

Course Outcomes:
- Design any logic circuit using CMOS transistor.
- Use different software tools for analysis of circuits.
- Design layouts to the CMOS circuits.
- Use different software tools for analog layout

List of Experiments:
1. Design and analysis of CMOS Inverter
   a) Implement CMOS inverter schematic using 180 nm technology and design its symbol.
   b) Implement test bench for CMOS Inverter and check its output response.
   c) Perform DC and AC analysis for CMOS inverter.
   d) Check the performance of CMOS inverter using parametric sweep.
2. Design and analysis of NAND and NOR Logic gates
   a) Implement NAND/NOR schematic using 180 nm technology and design its symbol.
   b) Implement test bench for NAND/NOR and check its output response.
   c) Perform DC and AC analysis for NAND/NOR.
   d) Check the performance of NAND/NOR using parametric sweep.
3. Design and analysis of XOR and XNOR Logic gates
   a) Implement XOR/XNOR schematic using 180 nm technology and design its symbol.
   b) Implement test bench for XOR/XNOR and check its output response.
   c) Perform DC and AC analysis for XOR/XNOR.
   d) Check the performance of XOR/XNOR using parametric sweep.
4. Design of AOI logic
   a) Design Schematic for AB+C'D and check its output response.
   b) Design Schematic for AB'+C'D and check its output response.
   c) Design Schematic for (A+B')(C+D) and check its output response.
   d) Design Schematic for (A+B')(C'+D) and check its output response.
5. Design and analysis of Full adder
   a) Design full adder using Full custom IC design.
   b) Design full adder using Semi custom IC design.
6. Analysis of NMOS and PMOS characteristics
   a) Implement test bench for NMOS/PMOS transistor.
   b) Perform DC and AC analysis for NMOS/PMOS transistor
   c) Check the performance of NMOS/PMOS transistor using parametric sweep.
7. Design and analysis of Common source amplifier
   a) Implement CS amplifier schematic using 180 nm technology and design its symbol.
   b) Implement test bench for CS amplifier and check its output response.
   c) Perform DC and AC analysis for CS amplifier.
   d) Check the performance of CS amplifier using parametric sweep.
8. Design and analysis of Common drain amplifier
   a) Implement CD amplifier schematic using 180 nm technology and design its symbol.
   b) Implement test bench for CD amplifier and check its output response.
   c) Perform DC and AC analysis for CD amplifier.
   d) Check the performance of CD amplifier using parametric sweep.
9. Design of MOS differential amplifier
   a) Design differential amplifier schematic using 180 nm technology and its symbol.
   b) Implement test bench for differential amplifier and check its output response.
   c) Perform DC and AC analysis for differential amplifier.
   d) Check the performance of differential amplifier using parametric sweep.

10. Design of two stage differential amplifier

a) Design two stage differential amplifier schematic using 180 nm technology and its symbol.

b) Implement test bench for two stage differential amplifier and check its output response.

c) Perform DC and AC analysis for two stage differential amplifier.

d) Check the performance of two stage differential amplifier using parametric sweep.

11. Design of Inverter Layout

a) Design and implement inverter schematic.

b) Design the layout for inverter using 180 nm tech file.

c) Perform LVS for schematic and layout

d) Check and remove all DRC violations.

e) Extract parasitic R and C in layout.

12. Design of NAND/NOR Layout

a) Design and implement NAND/NOR schematic.

b) Design the layout for inverter using 180 nm tech file.

c) Perform LVS for schematic and layout

d) Check and remove all DRC violations.

e) Extract parasitic R and C in layout

Note: Any TEN of the experiments are to be conducted

The students are required to design the schematic diagrams using CMOS logic and to draw the layout diagrams to perform the experiments with the Industry standard EDA Tools.

Software Required: i. Mentor Graphics Software / Equivalent Industry Standard Software. ii. Personal computer system with necessary software to run the programs and to implement.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem   **L   T   P   C**
                                                                             0   0   3   1.5

(20A04603P) DATA COMMUNICATION &NETWORKS LAB

Course Objectives:
To introduce Computer Network laboratory and familiarize with the tools by simulating various aspects of networking.

Course Outcomes:
- Familiarize with the network simulation tools
- Usage of the network simulators to study the various aspects that effect network performance

List of Experiments:
Introduction to Computer Network laboratory
Introduction to Discrete Event Simulation
Discrete Event Simulation Tools - ns2/ns3, Omnet++

Usage of the tool ns2/ns3 to:
1. Simulate telnet and ftp between N sources - N sinks (N = 1, 2, 3).
   Evaluate the effect of increasing data rate on congestion.
2. Simulating the effect of queueing disciplines on network performance - Random Early Detection/Weighted RED / Adaptive RED (This can be used as a lead up to DiffServ / IntServ later).
3. Simulate http, ftp and DBMS access in networks
4. Effect of VLAN on network performance –i) multiple VLANs and single router ii) multiple VLANs with separate multiple routers
5. Implementation of IP address configuration.
6. To create scenario and study the performance of network with CSMA / CA protocol and compare with CSMA/CD protocols.
7. Implementation of a routing algorithm
8. Simulation of Congestion Control Algorithms
9. Simulating the effect of DiffServ / IntServ in routers on throughput enhancement.
10. Simulating the performance of wireless networks
11. Case Study I: Evaluating the effect of Network Components on Network Performance To Design and Implement LAN With Various Topologies and To Evaluate Network Performance Parameters for DBMS etc)
12. Case Study II: Evaluating the effect of Network Components on Network Performance To Design and Implement LAN Using Switch/Hub/Router As Interconnecting Devices For Two Different LANs and To Evaluate Network Performance Parameters.

NOTE: At least 10 Experiments out of the list must be done in the semester.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (ECE)– III-II Sem	L	T	P	C
	1	0	2	2

(20A04607) RF SYSTEM DESIGN
Skill Oriented Course – IV

Course Objectives:
To be well-versed in functionalities of basic RF electronics utilized in the industry

Course Outcomes: After the completion of this course, students will be able to
- Verify the basic principles and design aspects involved in high frequency communication systems components
- Conduct the experiments on different high frequency components to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts.
- Design and develop RF components using microstrip technology
- Apply knowledge of basic RF Electronics for realizing any RF system.

UNIT I
Basic Concepts in RF Design: Introduce any RF design software and orient students with the tools of the laboratory. Practice the tool to use it for significant design.Introduction to RF Design, Time Variance and Nonlinearity, Effects of nonlinearity, Passive impedance transformation, Scattering parameters, impedance matching, L match, Pi match, T match, Passive IC Components- Resistors, capacitors Inductors, Schottky Diode, RF Switch.

UNIT II
RF Power Amplifiers and Filters: RF Power amplifier design examples, Gain equalizers, Voltage controlled oscillators, Phase locked loops, Linearized PLL models, PLL design examples, High frequency oscillators, Loop filters, lumped filter. LPF, HPF and BPF.

UNIT III
LNA, VCO and Mixers: General considerations, Problem of input matching, Low Noise Amplifiers design in various topologies, Gain Switching, Band Switching, Voltage Controlled Oscillators, Mixers-General considerations, Passive down conversion mixers, Active down conversion mixers, Up conversion mixers.

UNIT IV
Microstrip transmission lines and discontinuities: S parameters of a Microstrip Transmission Line, Smith Chart, Analysis of Microstrip Transmission Line standing wave patterns at various frequencies, Different types of Transmission lines like CPW, Microstrip and Co-axial cable. Different types of Microstrip discontinuities like Bend, T, Via, Gap etc., Microstrip Ring Resonator.

List of Experiments
(ADS/IE3D/HFSS or any similar/ equivalent tool may be used for the design)

1. Design of λ/2, λ/4 micro strip transmission line.
2. Design of microstrip inductor and capacitor
3. Design of impedance matching network
4. Design and Simulate a Schottky Diode and RF Switch.
5. Design and characterization of RF BJT Amplifier and LNA
6. Analyse and measure the gain of a Power Amplifier and equalise its gain using an Equalizer.
7. Design of low pass, high pass, band pass and band stop filter at RF
8. Design and characterization of RF Mixer
9. Design and characterization of VCO
10. Measure the S parameters of a Micro strip Transmission Line and plot the normalised impedance on a smith chart
11. Analysis of Microstrip Transmission Line standing wave pattern at various frequencies.
12. Study of different types of Transmission lines like CPW, Microstrip and Co-axial and find/measure its Insertion Loss (S21 and S12)
13. Study of different types of Microstrip discontinuities like Bend, T, Via , Gap etc and find/measure its Insertion loss.

14. Design and characterization of micro strip patch antennas
15. Determine the Bandwidth and Quality Factor of a Microstrip Ring Resonator.

NOTE: Any TWELVE experiments are to be conducted

References:
1. T.Lee, "Design of CMOS RF Integrated Circuits", Cambridge, 2004
2. Reinhold Ludwig and PavelBretchko, "RF circuit design," Pearson Education, 2007.
3. B.Razavi, "RF Microelectronics", Pearson Education, 2012

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
B.Tech (ECE)– III-II Sem   **L   T   P   C**
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(20A99601) INTELLECTUAL PROPERTY RIGHTS AND PATENTS
(Mandatory Non-Credit Course)

Course Objectives:
This course introduces the student to the basics of Intellectual Property Rights, Copy Right Laws, Cyber Laws, Trade Marks and Issues related to Patents. The overall idea of the course is to help and encourage the student for startups and innovations

Course Outcomes:
- Understand IPR law& Cyber law
- Discuss registration process, maintenance and litigations associated with trademarks
- Illustrate the copy right law
- Enumerate the trade secret law.

UNIT I
Introduction to Intellectual Property Law – Evolutionary past – Intellectual Property Law Basics – Types of Intellectual Property – Innovations and Inventions of Trade related Intellectual Property Rights – Agencies Responsible for Intellectual Property Registration – Infringement – Regulatory – Overuse or Misuse of Intellectual Property Rights –Compliance and Liability Issues.

UNIT II
Introduction to Copyrights – Principles of Copyright – Subject Matters of Copyright – Rights Afforded by Copyright Law –Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of performers – Copyright Formalities and Registration – Limitations – Infringement of Copyright – International Copyright Law-Semiconductor Chip Protection Act.

UNIT III
Introduction to Patent Law – Rights and Limitations – Rights under Patent Law – Patent Requirements – Ownership and Transfer – Patent Application Process and Granting of Patent – Patent Infringement and Litigation – International Patent Law – Double Patenting – Patent Searching – Patent Cooperation Treaty – New developments in Patent Law- Invention Developers and Promoters.

UNIT IV
Introduction to Trade Mark – Trade Mark Registration Process – Post registration procedures – Trade Mark maintenance – Transfer of rights – Inter parties Proceedings – Infringement – Dilution of Ownership of Trade Mark – Likelihood of confusion – Trade Mark claims – Trade Marks Litigation – International Trade Mark Law.

UNIT V
Introduction to Trade Secrets – Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreement – Trade Secret Law – Unfair Competition – Trade Secret Litigation – Breach of Contract – Applying State Law.Introduction to Cyber Law – Information Technology Act – Cyber Crime and E-commerce – Data Security – Confidentiality – Privacy – International aspects of Computer and Online Crime.

Textbooks:
1. Deborah E.Bouchoux: "Intellectual Property". Cengage learning, New Delhi
2. Kompal Bansal &Parishit Bansal "Fundamentals of IPR for Engineers", BS Publications (Press)
3. Cyber Law. Texts & Cases, South-Western's Special Topics Collections

References:
1. Prabhuddha Ganguli: ' Intellectual Property Rights" Tata Mc-Graw – Hill, New Delhi
2. Richard Stim: "Intellectual Property", Cengage Learning, New Delhi.
3. R. Radha Krishnan, S. Balasubramanian: "Intellectual Property Rights", Excel Books. New Delhi.
4. M. Ashok Kumar and Mohd. Iqbal Ali: "Intellectual Property Right" Serials Pub.

OPEN ELECTIVES

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech IV-I Sem	L	T	P	C
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(20A01605) ENVIRONMENTAL ECONOMICS
(Open Elective Course - II)

Course Objectives:
- To impart knowledge on sustainable development and economics of energy
- To teach regarding environmental degradation and economic analysis of degradation
- To inculcate the knowledge of economics of pollution and their management
- To demonstrate the understanding of cost benefit analysis of environmental resources
- To make the students to understand principles of economics of biodiversity

Course Outcomes :
After the completion of the course, the students will be able to know
- The information on sustainable development and economics of energy
- The information regarding environmental degradation and economic analysis of degradation
- The identification of economics of pollution and their management
- The cost benefit analysis of environmental resources
- The principles of economics of biodiversity

UNIT I

Sustainable Development: Introduction to sustainable development - Economy-Environment inter-linkages - Meaning of sustainable development - Limits to growth and the environmental Kuznets curve – The sustainability debate - Issues of energy and the economics of energy – Nonrenewable energy, scarcity, optimal resources, backstop technology, property research, externalities, and the conversion of uncertainty.

UNIT II

Environmental Degradation: Economic significance and causes of environmental degradation - The concepts of policy failure, externality and market failure - Economic analysis of environmental degradation – Equi –marginal principle.

UNIT - III

Economics of Pollution: Economics of Pollution - Economics of optimal pollution, regulation, monitoring and enforcement - Managing pollution using existing markets: Bargaining solutions – Managing pollution through market intervention: Taxes, subsidies and permits.

UNIT IV

Cost – Benefit Analysis: Economic value of environmental resources and environmental damage - Concept of Total Economic Value - Alternative approaches to valuation – Cost-benefit analysis and discounting.

UNIT V

Economics of biodiversity: Economics of biodiversity conservation - Valuing individual species and diversity of species -Policy responses at national and international levels. Economics of Climate Change – stern Report

Textbooks:
1. An Introduction to Environmental Economics by N. Hanley, J. Shogren and B. White Oxford University Press.(2001)
2. Blueprint for a Green Economy by D.W. Pearce, A. Markandya and E.B. Barbier Earthscan, London.(1989)

Reference Books:
1. Environmental Economics: An Elementary Introduction by R.K. Turner, D.W. Pearce and I. Bateman Harvester Wheatsheaf, London. (1994),
2. Economics of Natural Resources and the Environment by D.W. Pearce and R.K. Turner Harvester Wheat sheaf, London. (1990),
3. Environmental and Resource Economics: An Introduction by JMnichael S. Common and Michael Stuart 2nd Edition, Harlow: Longman.(1996),
4. Natural Resource and Environmental Economics by Roger Perman, Michael Common, Yue Ma and James Mc Gilvray 3rd Edition, Pearson Education.(2003),

Online Learning Resources:
https://nptel.ac.in/courses/109107171

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech III-II Sem	L	T	P	C
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(20A02605) SMART ELECTRIC GRID
(Open Elective Course-II)

Course Objectives:
- Understand recent trends in grids, smart grid architecture and technologies
- Analyze smart substations
- Apply the concepts to design smart transmission systems
- Apply the concepts to design smart distribution systems

Course Outcomes:
- Understand trends in Smart grids, needs and roles of Smart substations
- Design and Analyze Smart Transmission systems
- Design and Analyze Smart Distribution systems
- Analyze SCADA and DSCADA systems in practical working environment

UNIT I   INTRODUCTION TO SMART GRID

Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid

UNIT II   SMART GRID TECHNOLOGIES

Characteristics of Smart grid, Micro grids, Definitions, Drives, benefits, types of Micro grid, building blocks, Renewable energy resources, needs in smart grid, integration impact, integration standards, Load frequency control, reactive power control, case studies and test beds

UNIT III   SMART SUBSTATIONS

Protection, Monitoring and control devices, sensors, SCADA, Master stations, Remote terminal unit, interoperability and IEC 61850, Process level, Bay level, Station level, Benefits, role of substations in smart grid, Volt/VAR control equipment inside substation

UNIT IV   SMART TRANSMISSION SYSTEMS

Energy Management systems, History, current technology, EMS for the smart grid, Synchro Phasor Measurement Units (PMUs), Wide Area Monitoring Systems (WAMS), protection & Control (WAMPC), needs in smart grid, Role of WAMPC smart grid, Drivers and benefits, Role of transmission systems in smart grid

UNIT V   SMART DISTRIBUTION SYSTEMS

DMS, DSCADA, trends in DSCADA and control, current and advanced DMSs, Voltage fluctuations, effect of voltage on customer load, Drivers, objectives and benefits, voltage-VAR control, VAR control equipment on distribution feeders, implementation and optimization, FDIR - Fault Detection Isolation and Service restoration (FDIR),faults, objectives and benefits, equipment, implementation

Textbooks:
1. Stuart Borlase, Smart Grids - Infrastructure, Technology and Solutions, CRC Press, 1e, 2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press, 2e, 2013.

Reference Books:
1. A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Applications, Springer Edition, 2e, 2017.
2. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2e, 2012.

Online Learning Resources:
1. https://onlinecourses.nptel.ac.in/noc22_ee82/preview

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech IV-I Sem   **L   T   P   C**
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(20A03605c) INTRODCUTION TO ROBOTICS
(Open Elective-II)

Course Objectives:
- Learn the fundamental concepts of industrial robotic technology.
- Apply the basic mathematics to calculate kinematic and dynamic forces in robot manipulator.
- Understand the robot controlling and programming methods.
- Describe concept of robot vision system

Course Outcomes:

After completing the course, the student will be able to,
- Explain fundamentals of Robots
- Apply kinematics and differential motions and velocities
- Demonstrate control of manipulators
- Understand robot vision
- Develop robot cell design and programming

UNIT I   Fundamentals of Robots

Introduction, definition, classification and history of robotics, robot characteristics and precision of motion, advantages, disadvantages and applications of robots. Introduction to matrix representation of a point in a space a vector in space, a frame in space, Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis.

UNIT II   Kinematics, Differential motions and velocities of robot

Kinematics of robot: Forward and inverse kinematics of robots- forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg(D-H) representation of forward kinematic equations of robots, the inverse kinematic of robots, degeneracy and dexterity, simple problems with D-H representation.

Differential motions and Velocities: Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

UNIT III   Control of Manipulators

Open- and close-loop control, the manipulator control problem, linear control schemes, characteristics of second-order linear systems, linear second-order SISO model of a manipulator joint, joint actuators, partitioned PD control scheme, PID control Scheme, computer Torque control, force control of robotic manipulators, description of force-control tasks, force control strategies, hybrid position/force control, impedance force/torque control.

UNIT IV   Robot Vision

Introduction, architecture of robotic vision system, image processing, image acquisition camera, image enhancement, image segmentation, imaging transformation, Camera transformation and calibrations, industrial applications of robot vision.

UNIT V   Robot Cell Design and Programming

Robot cell layouts-Robot centred cell, In-line robot cell, considerations in work cell design, work cell control, interlocks, error detection, work cell controller. methods of robot programming, WAIT, SIGNAL, and DELAY commands, Robotic languages, VAL system.

Textbooks:
1. Mikell P. Groover and Mitchell Weiss, Roger N. Nagel,Nicholas G.Odrey , Industrial Robotics — Mc Graw Hill, 1986.
2. R K Mittal and I J Nagrath, Robotics and control, Illustrated Edition, Tata McGraw Hill India 2003.

References:
1. Saeed B. Niku, Introduction to Robotics – Analysis, System, Applications, 2nd Edition, John Wiley & Sons, 2010.
2. H. Asada and J.J.E. Slotine, Robot Analysis and Control, 1st Edition Wiley- Interscience, 1986.
3. Robert J. Schillin, Fundamentals of Robotics: Analysis and control, Prentice-Hall Of India Pvt. Limited, 1996.

Online Learning Resources:

https://nptel.ac.in/courses/108105088

https://nptel.ac.in/courses/108105063

https://nptel.ac.in/courses/108105062

https://nptel.ac.in/courses/112104288

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech III-II Sem
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(20A05605a) PRINCIPLES OF OPERATING SYSTEMS
(Open Elective Course – II)

Course Objectives:
- Understand basic concepts and functions of operating systems
- Understand the processes, threads and scheduling algorithms.
- Expose the students with different techniques of handling deadlocks
- Provide good insight on various memory management techniques
- Explore the concept of file-system and its implementation issues

Course Outcomes:
- Demonstrate and understand of computer systems and operating systems functions
- Distinguish between process and thread and classify scheduling algorithms
- Solve synchronization and deadlock problems
- Compare various memory management schemes
- Explain file systems concepts and i/o management

UNIT I   **Introduction to Computer and Operating system**

Computer Types, Functional Units, Basic Operational Concepts, Number Representation and Arithmetic Operations, Character Representation, Performance, Historical Perspective, Memory Locations and Addresses, Memory operations, Instructions and Instruction Sequencing, Addressing modes
Architecture Operating System Structure, Operations Process, Memory, Storage Management, Protection and Security Computing Environments Operating System Services User Operating System Interface System Calls Types System Programs OS Structure OS Generation System Boot.

UNIT II   **Process, Threads and Scheduling**

Process Concept Scheduling Operations on Processes Cooperating Processes Inter-Process Communication Threads - Multithreading Models -Thread Libraries- Threading Issues – Scheduling Criteria Scheduling Algorithms Algorithm Evaluation.

UNIT III   **Process Synchronization and Deadlocks**

The Critical-Section Problem Synchronization Hardware Mutex Locks -Semaphores Classic Problems of Synchronization Critical Regions Monitors Deadlocks System Model Deadlock Characterization Methods for Handling Deadlocks Deadlock Prevention Deadlock Avoidance Deadlock Detection Recovery from Deadlock.

UNIT IV   **Memory Management**

Introduction - Swapping Contiguous Memory Allocation Paging Segmentation- Structure of the Page Table - Virtual Memory- Background Demand Paging Copy on Write Page Replacement Allocation of Frames Thrashing.

UNIT V   **Input/ Output and Files**

Overview of Mass Storage Structure - Disk Structure - Disk Scheduling and Management-File System Interface File Concept - Access Methods -Directory and Disk Structure- Directory Implementation - Allocation Methods- I/O Systems I/O Hardware- Application I/O Interface - Kernel I/O Subsystem.

Textbooks:
1. Carl Hamacher, ZvonkoVranesic, SafwatZaky and NaraigManjikian, Computer Organization and Embedded Systems, Sixth Edition, Tata McGraw Hill, 2012.
2. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating Systems Concepts, Ninth Edition, Wiley,2012.

Reference Books:
1. William Stallings, Operating Systems: Internals and Design Principles, Ninth Edition, Prentice-Hall, 2018.
2. Andrew Tanenbaum, Modern Operating Systems, Third Edition, Prentice Hall, 2009.

Online Learning Resources:
https://nptel.ac.in/courses/106/106/106106144/
http://peterindia.net/OperatingSystems.html

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech III-II Sem

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(20A05605b) FOUNDATIONS OF MACHINE LEARNING
Open Elective Course– II

Course Objectives:
- Acquire theoretical knowledge on setting hypothesis for pattern recognition.
- Apply suitable machine learning techniques for data handling and to gain knowledge from it.
- Evaluate the performance of algorithms and to provide solution for various real-world applications.

Course Outcomes (CO):
After completion of the course, students will be able to
1. Understand the characteristics of machine learning strategies.
2. Apply various supervised learning methods to appropriate problems.
3. Identify and integrate more than one technique to enhance the performance of learning.
4. Create probabilistic and unsupervised learning models for handling unknown pattern.
5. Analyse the co-occurrence of data to find interesting frequent patterns.
6. Pre-process the data before applying to any real-world problem and can evaluate its performance

UNIT - I   **Introduction to Machine Learning**   Lecture 8Hrs

What is machine learning, learning associations, classification, regression, unsupervised learning, reinforcement learning
Supervised Learning: learning a class from examples, learning multiple classes, model selection and generalization

UNIT - II   **Parametric, Non-Parametric methods**   Lecture 9Hrs

Parametric Methods: Introduction, maximum likelihood estimation, evaluating an estimator, parametric classification, regression, model selection procedures
Nonparametric Methods: Introduction, nonparametric density estimation: histogram estimator, kernel estimator, k-nearest neighbour estimator

UNIT - III   **Multivariate Methods**   Lecture 9Hrs

Multivariate Methods: Multivariate data, parameter estimation, estimation of missing values, multivariate normal distribution, multi variate classification

UNIT - IV   **Dimensionality Reduction, Clustering**   Lecture 8Hrs

Dimensionality Reduction: Introduction, subset selection, principal component analysis, singular value decomposition and matrix factorization
Clustering: Mixture densities, k-means clustering, expectation-maximization algorithm, mixtures of latent variables

UNIT - V   **Deep Learning**   Lecture 8Hrs

Deep Learning: Introduction, train multiple hidden layers, improving training convergence, regularization, convolution layers, tuning the network structure, learning sequences.

Textbooks:
1. EthemAlpaydin, Introduction to Machine Learning, Fourth Edition, MIT Press, Fourth Edition, 2020
2. MehryarMohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2012

Reference Books:
1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2019.
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd Edition, CRC Press, 2015.
3. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.

Online Learning Resources:
1. https://bloomberg.github.io/foml/
2. https://d1rkab7tlqy5f1.cloudfront.net/EWI/Over%20de%20faculteit/Afdelingen/Intelligent%20Systems/Pattern%20Recognition%20Laboratory/PR/Reading%20Group/Foundations_of_Machine_Learning.pdf

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (IT)– III-II Sem	L	T	P	C
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(20A05605c) DATA ANALYTICS USING R
(Open Elective-II)

Course Objectives:
- Facilitate students to understand R programming
- Help students to gain a basic understanding of Data Analytics
- Inculcate working knowledge of plotting

Course Outcomes:
- Identify and execute basic syntax and programs in R
- Perform the Matrix operations using R built in functions
- Apply nonnumeric values in vectors
- Create the list and data frames
- Exploit the graph using ggplot2.

UNIT I   Introduction to R Programming

History and Overview of R- Basic Features of R-Design of the R System- Installation of R- Console and Editor Panes- Comments- Installing and Loading R Packages- Help Files and Function Documentation-Saving Work and Exiting R- Conventions- R for Basic Math- Arithmetic- Logarithms and Exponentials - E-Notation - Assigning Objects – Vectors - Creating a Vector-Sequences, Repetition, Sorting and Lengths – Subsetting and Element Extraction -Vector – Oriented Behavior.

UNIT II   Matrices and Arrays

Defining a Matrix – Defining a Matrix- Filling Direction- Row and Column Bindings- Matrix Dimensions-Subsetting- Row, Column, and Diagonal Extractions- Omitting and Overwriting- Matrix Operations and Algebra- Matrix Transpose- Identity Matrix- Matrix Addition and Subtraction- Matrix Multiplication-Matrix Inversion-Multidimensional Arrays-Subsets, Extractions and Replacements.

UNIT III   Non-Numeric values

Logical Values- Relational Operators- Characters- Creating a String- Concatenation- Escape Sequences-Substrings and Matching- Factors- Identifying Categories- Defining and Ordering Levels- Combining and Cutting.

UNIT IV   Lists and Data frames

List of Objects - Component Access – Naming – Nesting - Data Frames - Adding Data Columns and Combining Data Frames – Logical Record Subsets – Some Special Values – Infinity – NaN – NA - NULL – Attributes – Object - Class-Is-Dot Object-Checking Functions-As-Dot Coercion Functions

UNIT V   Basic Plotting

Using plot with Coordinate Vectors-Graphical Parameters-Automatic Plot Types-Title and Axis Labels-Color-Line and Point Appearances-Plotting Region Limits-Adding Points, Lines, and Text to an ExistingPlot-ggplot2 Package-Quick Plot with qplot-Setting Appearance Constants with Geoms—Reading and Writing Files- R-Ready Data Sets- Contributed Data Sets- Reading in External Data Files- Writing Out Data Files and Plots-AdHoc Object Read/Write Operations

Textbooks:
1. Tilman M. Davies, "The Book of R-A First Programming, Statistics" Library of Congress Cataloging-in-Publication Data, 2016.

Reference Books:
1. Hadley Wickham, Garrett Grolemund,"R for Data Science",Oreilly Publication,2017.
2. Roger D. Peng, "R Programming for Data Science" Lean Publishing, 2016.
3. Steven Keller, "R ProgrammingforBeginners",CreateSpaceIndependentPublishingPlatform2016.

Online Learning Resources:
1. https://www.coursera.org/learn/data-analysis-r
2. https://www.careers360.com/courses-certifications/data-analysis-with-r-courses-brpg

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech III-II Sem **L   T   P   C**
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(20A27605) FOOD REFRIGERATION AND COLD CHAIN MANAGEMENT
OPEN ELECTIVE II

Course Objectives:
- To know the equipment available to store perishable items for a long time
- To understand to increase the storage life of food items

Course Outcomes

By the end of the course, the students will
- Understand various principles and theories involved in refrigeration systems
- Understand the different equipment useful to store the food items for a long period.
- Understand how to increase the storage life of food items

UNIT I

Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization; Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures;

UNIT II

Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry vs wet compression, throttling vs isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling;

UNIT III

Liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid sub cooling, actual vapour compression cycle; Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine, Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical; Azeotropes; Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve;

UNIT IV

Ice manufacture, principles and systems of ice production, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations; Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display;

UNIT V

Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers; Cooling load calculations: Load sources, product cooling, conducted heat, convicted heat, internal heat sources, heat of respiration, peak load; etc.

Textbooks:
1. Arora, C. P. "Refrigeration and Air Conditioning". Tata MC Graw Hill Publishing Co.Ltd., New Delhi. 1993.

References:
1. Adithan, M. and Laroiya, S. C. "Practical Refrigeration and Air Conditioning". Wiley Estern Ltd., New Delhi 1991

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech III-II Sem   **L   T   P   C**
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(20A54701) WAVELET TRANSFORMS AND ITS APPLICATIONS
(Open Elective-II)

Course Objectives:
This course provides the students to understand Wavelet transforms and its applications.

Course Outcomes:
- Understand wavelets and wavelet expansion systems.
- Illustrate the multi resolution analysis ad scaling functions.
- Form fine scale to coarse scale analysis.
- Find the lattices and lifting.
- Perform numerical complexity of discrete wavelet transforms.
- Find the frames and tight frames using fourier series.

UNIT I   Wavelets
Wavelets and Wavelet Expansion Systems - Wavelet Expansion- Wavelet Transform- Wavelet System- More Specific Characteristics of Wavelet Systems -Haar Scaling Functions and Wavelets - effectiveness of Wavelet Analysis -The Discrete Wavelet Transform the Discrete-Time and Continuous Wavelet Transforms.

UNIT II   A Multiresolution Formulation of Wavelet Systems
Signal Spaces -The Scaling Function -Multiresolution Analysis - The Wavelet Functions - The Discrete Wavelet Transform- A Parseval's Theorem - Display of the Discrete Wavelet Transform and the Wavelet Expansion.

UNIT III   Filter Banks and the Discrete Wavelet Transform
Analysis - From Fine Scale to Coarse Scale- Filtering and Down-Sampling or Decimating -Synthesis - From Coarse Scale to Fine Scale -Filtering and Up-Sampling or Stretching - Input Coefficients - Lattices and Lifting - -Different Points of View.

UNIT IV   Time-Frequency and Complexity
Multiresolution versus Time-Frequency Analysis- Periodic versus Nonperiodic Discrete Wavelet Transforms -The Discrete Wavelet Transform versus the Discrete-Time Wavelet Transform- Numerical Complexity of the Discrete Wavelet Transform.

UNIT V   Bases and Matrix Examples
Bases, Orthogonal Bases, and Biorthogonal Bases -Matrix Examples - Fourier Series Example - Sine Expansion Example - Frames and Tight Frames - Matrix Examples -Sine Expansion as a Tight Frame Example.

Textbooks:
1. C. Sidney Burrus, Ramesh A. Gopinath, "Introduction to Wavelets and Wavelets Transforms",Prentice Hall, (1997).
2. James S. Walker, "A Primer on Wavelets and their Scientific Applications", CRC Press, (1999).

Reference Books:
1. Raghuveer Rao, "Wavelet Transforms", Pearson Education, Asia.

Online Learning Resources:
https://www.slideshare.net/RajEndiran1/introduction-to-wavelet-transform-51504915

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech III-II Sem   **L T P C**
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(20A56701) PHYSICS OF ELECTRONIC MATERIALS AND DEVICES
(Open Elective-II)

Course Objectives:
- To impart the fundamental knowledge on various materials, their properties and applications.
- To provide insight into various semiconducting materials, and their properties.
- To enlighten the characteristic behavior of various semiconductor devices.
- To provide the basics of dielectric and piezoelectric materials and their properties.
- To explain different categories of magnetic materials, mechanism and their advanced applications.

Course Outcome: At the end of the course the student will be able
- To understand the fundamentals of various materials.
- To exploit the physics of semiconducting materials
- To familiarize with the working principles of semiconductor-based devices.
- To understand the behaviour of dielectric and piezoelectric materials.
- To identify the magnetic materials and their advanced applications.

UNIT I Fundamentals of Materials Science
Introduction, Phase rule, Phase Diagram, Elementary idea of Nucleation and Growth, Methods of crystal growth. Basic idea of point, line and planar defects. Concept of thin films, preparation of thin films, Deposition of thin film using sputtering methods (RT and glow discharge).

UNIT II Semiconductors
Introduction, charge carriers in semiconductors, effective mass, Diffusion and drift, Diffusion and recombination, Diffusion length. The Fermi level & Fermi-Dirac distribution, Electron and Hole in quantum well, Change of electron-hole concentration- Qualitative analysis, Temperature dependency of carrier concentration, Conductivity and mobility, Effects of temperature and doping on mobility, High field effects.

UNIT III Physics of Semiconductor devices
Introduction, Band structure, PN junctions and their typical characteristics under equilibrium and under bias, Construction and working principles of: Light emitting diodes, Heterojunctions, Transistors, FET and MOSFETs.

UNIT IV Dielectric Materials and their applications:
Introduction, Dielectric properties, Electronic polarizability and susceptibility, Dielectric constant and frequency dependence of polarization, Dielectric strength and dielectric loss, Piezoelectric properties.

UNIT V Magnetic Materials and their applications
Introduction, Magnetism & various contributions to para and dia magnetism, Ferro and Ferri magnetism and ferrites, Concepts of Spin waves and Magnons, Anti-ferromagnetism, Domains and domain walls, Coercive force, Hysteresis, Nano-magnetism, Super-paramagnetism – Properties and applications.

Textbooks
1. Principles of Electronic Materials and Devices- S.O. Kasap, McGraw-Hill Education (India) Pvt. Ltd., 3rd edition, 2007.
2. Electronic Components and Materials- Grover and Jamwal, Dhanpat Rai and Co.

Reference Books:
1. Solid State Electronic Devices -B.G. Streetman and S. Banerjee, PHI Learning, 6th edition
2. Electronic Materials Science- Eugene A. Irene, , Wiley, 2005
3. An Introduction to Electronic Materials for Engineers-Wei Gao, Zhengwei Li, Nigel Sammes, World Scientific Publishing Co. Pvt. Ltd., , 2nd Edition,2011
4. A First Course In Material Science- by Raghvan, McGraw Hill Pub.
5. The Science and Engineering of materials- Donald R.Askeland, Chapman& Hall Pub.

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https://onlinecourses.nptel.ac.in/noc20_mm02/preview,
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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech III-II Sem   **L   T   P C**

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(20A51701) CHEMISTRY OF POLYMERS AND ITS APPLICATIONS

Course Objectives:
- To understand the basic principles of polymers
- To synthesize the different polymeric materials and their characterization by various instrumental methods.
- To impart knowledge to the students about fundamental concepts of Hydro gels of polymer networks, surface phenomenon by micelles
- To enumerate the applications of polymers in engineering

Course Outcome
- At the end of the course, the student will be able to:
- Understand the state of art synthesis of Polymeric materials
- Understand the hydro gels preparation, properties and applications in drug delivery system.
- Characterize polymers materials using IR, NMR, XRD.
- Analyze surface phenomenon fo micelles and characterise using photoelectron spectroscopy, ESCA and Auger spectroscopy

UNIT I : Polymers-Basics and Characterization

Basic concepts: monomers, repeat units, degree of polymerization, linear, branched and network polymers, classification of polymers, Polymerization: condensation, addition, radical chain, ionic and coordination and copolymerization. Average molecular weight concepts: number, weight and viscosity average molecular weights, polydispersity and molecular weight distribution Measurement of molecular weight: end group, viscosity, light scattering, osmotic and ultracentrifugation methods, analysis and testing of polymers.

Unit II : Synthetic Polymers

Addition and condensation polymerization processes – Bulk, Solution, Suspension and Emulsion polymerization.

Preparation and significance, classification of polymers based on physical properties, Thermoplastics, Thermosetting plastics, Fibers and elastomers, General Applications.

Preparation of Polymers based on different types of monomers, Olefin polymers, Diene polymers, nylons, Urea - formaldehyde, phenol - formaldehyde and melamine Epoxy and Ion exchange resins. Characterization of polymers by IR, NMR, XRD.

UNIT III : Natural Polymers & Modified cellulosics

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins.

Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals, Liquid crystalline polymers; specialty plastics- PES, PAES, PEEK, PEAK.

Learning Outcomes:

UNIT IV: Hydrogels of Polymer networks and Drug delivery

Definitions of Hydrogel, polymer networks, Types of polymer networks, Methods involved in hydrogel preparation, Classification, Properties of hydrogels, Applications of hydrogels in drug delivery.

Introduction to drug systems including, drug development, regulation, absorption and disposition, routes of administration and dosage forms. Advanced drug delivery systems and controlled release.

UNIT V : Surface phenomena

Surface tension, adsorption on solids, electrical phenomena at interfaces including electrokinetics, micelles, reverse micelles, solubilization. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces.

References :
1. A Text book of Polymer science, Billmayer
2. Organic polymer Chemistry, K.J.Saunders, Chapman and Hall
3. Advanced Organic Chemistry, B.Miller, Prentice Hall
4. Polymer Chemistry – G.S.Mishra
5. Polymer Chemistry – Gowarikar
6. Physical Chemistry –Galston
7. Drug Delivery- Ashim K. Misra