College of Engineering, Pune

(An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

Department of Electronics and Telecommunication

Curriculum Structure & Detailed Syllabus (UG Program)

Final Year B. Tech.

(Effective from: A.Y. 2022-23)

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Program Education Objectives (PEOs):

Graduates will demonstrate ability to:

1. Solve real-life engineering problems, design and development of innovative and cost-effective products exhibiting a solid foundation in Electronics and Communication Engineering fundamentals to cater needs of society.
2. Excel in Industry/technical profession, higher studies, and entrepreneurship exhibiting global competitiveness.
3. Exhibit professional ethics and values, effective communication, teamwork, multidisciplinary approach, and ability to relate engineering issues to broader social context.

Program Outcomes (POs):

Graduates of Electronics & Telecommunication Engineering by the time of graduation will demonstrate:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program specific outcomes (PSOs)

PSO 1: Development of Hardware/Software Co-designs: An ability to apply electronic design principles in the development of hardware/software prototypes and systems with progressive depth of complexity.

PSO 2: Development of Electronics Communication Systems: An ability to deploy conventional & next-gen. techniques/tools for analysis & design of Information and Communication systems.

PSO 3: Development of Signal Processing Applications: An ability to apply algorithmic knowledge of signal processing towards analysis, Recognition, and synthesis of multi-dimensional data.

PEO/ PO-PSO Correlation Matrix

3- High, 2- Medium, 1- Low

PEO/ PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
PEO-1	√	√	√	√	√	√	√	-	-	-	√	√	√	√	√
PEO-2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO-3	-	-	√	-	-	-	√	√	√	√	√	√	√	√	√

List of Abbreviations

Sr. No.	Abbreviation	Title
1	BSC	Basic Science Course
2	ESC	Engineering Science Course
3	MLC	Mandatory Learning Course
4	SLC	Self-Learning Course
5	HSMC	Humanities/Social Sciences/Management Course
6	LLC	Liberal Learning Course
7	SBC	Skill Based Course
8	IFC	Interdisciplinary Foundation Course
9	IOC	Interdisciplinary Open Course
10	DEC	Department Elective Course
11	PCC	Program Core Course
12	LC	Laboratory Course

Final Year BTech E&TC Revised Structure (wef AY- 2022-23)

Semester VII: Scheme A

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	LLC	LL-22001-17	Liberal Learning Course	1	0	0	1
2	MLC	ML-22001	Intellectual Property Rights	1	0	0	0
3	IOC	IOC-22001-9	Interdisciplinary Open Course - II	2	0	0	2
4	DEC	ET(DE)-22001 ET(DE)-22002 ET(DE)-22003	Department Elective-II 1. Fiber Optic Communications 2. VLSI Physical Design 3. Electric Vehicle Technologies	3	0	0	3
5	PCC1	ET-22001	Mobile Communication	3	0	0	3
6	PCC2	ET-22002	Embedded System Design	2	0	0	2
7	PCC3	ET-22003	Deep Learning and Edge Intelligence	2	0	0	2
8	LC1	ET-22004	Mobile Communication Lab	0	0	2	1
9	LC2	ET-22005	Embedded System Design Lab	0	0	2	1
10	LC3	ET-22006	Deep Learning and Edge Intelligence Lab	0	0	2	1
Total Academic Engagement and Credits				14	0	6	16

Semester VIII: Scheme A

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	DEC	ET(DE)22004 ET(DE)22005 ET(DE)22006	Department Elective-III 1. Embedded Software and RTOS 2. Analog CMOS design 3. Microwave and Radar	3	0	0	3
2	DEC	ET(DE)22007 ET(DE)22008 ET(DE)22009	Department Elective-IV 1. Biomedical Engineering 2. VLSI Design Verification 3. Natural Language Processing	3	0	0	3
3	SBC	ET- 22007	Project	0	0	16	8
Total Academic Engagement and Credits				6	0	16	14

Honour Courses in E&TC:

1. Cognitive Radio (Sem-VII) ET(HO)-22001
2. Software Defined Networks (Sem-VIII) ET(HO)-22002

Minor Courses in IoT:

1.Digitalization and IoT Applications (Sem-VII) ET(MI)-22001

2.Cloud Computing and IoT Platforms (Sem-VIII) ET(MI)-22002

Semester VII: Scheme B

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	LLC	LL-22001-17	Liberal Learning Course	1	0	0	1
2	MLC	ML-22001	Intellectual Property Rights	1	0	0	0
3	IOC	IOC-22001-9	Interdisciplinary Open Course - II	2	0	0	2
4	DEC	ET(DE)-22001 ET(DE)-22002 ET(DE)-22003	Department Elective-II 1. Fiber Optic Communications 2. VLSI Physical Design 3. Electric Vehicle Technologies	3	0	0	3
5	PCC1	ET-22001	Mobile Communication	3	0	0	3
6	PCC2	ET-22002	Embedded System Design	2	0	0	2
7	PCC3	ET-22003	Deep Learning and Edge Intelligence	2	0	0	2
8	LC1	ET-22004	Mobile Communication Lab	0	0	2	1
9	LC2	ET-22005	Embedded System Design Lab	0	0	2	1
10	LC3	ET-22006	Deep Learning and Edge Intelligence Lab	0	0	2	1
Total Academic Engagement and Credits				14	0	6	16

Semester VIII: Scheme B

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	SLC	ET(OC)-22001	Massive Open Online Course –I	3	0	0	3
2	SLC	ET(OC)-22002	Massive Open Online Course –II	3	0	0	3
3	SBC	ET-22008	Internship and Project (Industry/Corporate/Academia)	0	0	16	8
Total Academic Engagement and Credits				6	0	16	14

Sem VII

(ET (DE)-22001) Fiber Optic Communications

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Explain the principles and advantages of fiber optic communication.
2. Describe the modes propagating in optical fiber using mode theory.
3. Analyse the performance of optical sources and detectors.
4. Estimate the power and rise time budget for an optical link.
5. Illustrate the concepts and components used in WDM.
6. Design an optical network and analyse its performance.

Unit 1 **(4 hrs)**

Overview of Optical Fiber Communications: Motivations for Lightwave communications, optical spectral bands, decibel units, network information rates, key elements of optical fiber systems, Standards for optical fiber communications.

Unit 2 **(8 hrs)**

Optical Fibers: Structures Waveguiding and Fabrication: Introduction to vector nature of light, basic optical laws and definitions, optical fiber modes and configurations, Mode theory of circular waveguide, Single mode fibers, Graded index fibers, Fiber materials, Photonic crystal fibers, Fiber fabrication, Mechanical properties of fiber,

Unit 3 **(8 hrs)**

Transmission Characteristics of Optical Fiber: Attenuation, Material absorption loss, Scattering loss, Bending Loss, Dispersion, Chromatic dispersion, Intermodal dispersion, Polarization mode dispersion, Dispersion modified single mode fibers. International fiber standards

Unit 4 **(8 hrs)**

Optical Sources, Detectors and Link Design: LEDs and Laser Diodes, Photo detectors pin-diodes, APDs, detector responsivity, noise, Optical receivers. Optical link design, Power budget and Rise Time Budget.

Unit 5 **(6 hrs)**

WDM Concepts and Components: Overview of Wavelength Division Multiplexing, Passive Optical Couplers, Isolator and Circulators, Fiber grating filters, Active optical components, Tuneable light sources, Erbium Doped Fiber Amplifier, Raman Amplifier

Unit 6 **(8 hrs)**

Optical Networks: Network Concepts, Network topologies, SONET/SDH, High speed light wave links, Optical Add/Drop Multiplexing, Optical Switching, Passive Optical Networks, Optical Ethernet, Optical Fiber System performance monitoring and Measurement, Optical Time Domain Reflectometer(OTDR).

Textbooks:

- Gerd Keiser, "Fibre Optic communication", McGraw-Hill, 5th Edition, 2010
- John M Senior," Optical Fiber Communications Principles and Practice", Pearson 3rd Edition,

Reference Book:

- Siva Ram Murth, Mohan Guruswamy " WDM Optical Networks Concepts Design and Algorithms" ,PHI Eastern Economy ,Edition,2001

(ET (DE)-22002) VLSI Physical Design

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Illustrate the concepts of Physical Design Process such as partitioning, Floor planning, Placement and Routing.
2. Apply the basic timing concepts and STA methodology to address the timing violations
3. Apply the concepts in design optimization algorithms and their application to physical design automation.
4. Identify the design for testability methods for combinational & sequential CMOS circuits
5. Analyse various techniques for dynamic and leakage power reduction at various level of abstraction.

Unit 1 **(4 hrs)**

Physical design flow overview: Overall flow of physical design, Libraries, Partitioning, Floor planning and Placement, timing and clock tree synthesis parasitic extraction, DRC clean, final stage

Unit 2 **(8 hrs)**

Partitioning, Floor planning and placement: Floor planning algorithm, Block placement. I/O placement, power planning, standard cell placement

Unit 3 **(8 hrs)**

Timing closure: Set time and hold time of FF, clock skew and jitter, STA with multiple clock, Clock tree synthesis and signal integrity: H tree algorithm, cross talk, clock shielding,

Unit 4 **(8 hrs)**

Routing and DRC: Clock nets, critical nets in timing, critical nets in positioning, parasitic extraction: Formats for extraction, Interconnect Modelling and Layout Compaction

Unit 5 **(6 hrs)**

Testing of VLSI circuits: Types of faults, fault modelling and simulation, test pattern generation, DFT, BIST

Unit 6 **(8 hrs)**

Low power VLSI design: dynamic and static power, clock gating techniques, Voltage island, approach of using parallelism and pipeline.

Textbooks:

- Khosrow Golshan, "Physical Design Essentials: An ASIC Design Implementation Perspective", Springer, 2007
- Bushnell & Agrawal, "Essentials Of Electronic Testing For Digital, Memory And Mixed-Signal Vlsi Circuits", Kluwer Academic Publishers, 2000
- P. Rashinkar, Paterson and L. Singh, "Low Power Design Methodologies", Kluwer Academic, 2002
- Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" , Wiley

Reference Book:

- S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley ,1998

(ET(DE)-22003) Electric Vehicle Technologies

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Explain the different electrical vehicle technologies.
2. Compare Brushed and Brushless DC motor construction and its merits.
3. Identify automotive electronics sensors, actuators, controls in EV
4. Analysis of various feature of Advanced Driver Assistance System

5. Explain the Communication Protocols used in EV
6. Analyse the Certification and Standardization process

Unit 1 **(4 hrs)**

Introduction: Sustainable transportation, environment, new fuel economy requirement, evolution and necessity of electric vehicles, block diagram of EV, Batteries parameters, types: Lead acid, Nickel; sodium; lithium based, metal air, charging, safety and recyclability aspects, novel energy sources such as fuel cells, hydrogen.

Unit 2 **(4 hrs)**

Electric machines and their controllers: Induction motor drives, permanent magnet motor drives, switched reluctance motors, Brushed DC motor, DC regulation and voltage conversion, Brushless DC motor, cooling system, efficiency, size and mass, design considerations, design of ancillary systems. Electric vehicle body and chassis design

Unit 3 **(8 hrs)**

Automotive Electronics in Vehicles: Sensors and Actuators: pressure, linear, angle position, flow, temperature, heat, humidity, exhaust gas, speed and acceleration, engine knock, engine torque and actuators. Control: engine, braking, traction, stability, suspension, steering, wipers, air conditioning/ heating. Introduction to Advanced Driver Assistance System Levels 0 to 5

Unit 4 **(10 hrs)**

Advanced Driver Assistance System(ADAS): Advaned Features of ADAS such as adaptive cruise control (ACC); glare free high beam and pixel light; adaptive light control: curve lights; automatic parking, automotive navigation system with global positioning system (GPS) and traffic management control(TMC) ; automotive night vision; blind spot monitor; collision avoidance system; crosswind stabilization; driver drowsiness detection and monitoring; electric vehicle warning sounds used in hybrid and plug in systems; emergency driver assistance, forward collision warning; intersection assistant ; intelligent speed adaption; lane departure warning; parking sensor; pedestrian protection system; rain sensor; surround view system; tire pressure monitoring; traffic sign recognition; turning assistant; wrong way driving assistant.

Unit 5 **(8 hrs)**

Modern Communication Technology: Vehicular communication systems,5G/6G/ XX in vehicles: Displays and information systems: Instrument panel display technologies such as vacuum fluorescent, LCD, On and off board diagnostics, safety, entertainment, intelligent transportation systems. Role of cloud computing in deployment of higher stages of ADAS, Vehicular Ad-Hoc Network (VANET), MANET, Vehicle to vehicle communication protocol V2V, CAN protocol and communication bus within vehicle especially gigabit automotive ethernet, Radar for automotive (ADAS) solutions.

Unit 6 **(6 hrs)**

Case studies of EV: Case Studies of Re chargeable battery vehicles, Hybrid vehicles, Fuel cell powered Bus; Wireless power transfer for electric vehicle, vehicular power control strategy and energy management, EMI/EMC, Commercialization of Vehicle technology, Electric vehicles Certification and Standardization: ARAI certification process, Functional Saftey in Automotive Vehicles, ISO 26262.

Textbooks:

- Chris Mi and M. Abdul Masrur, "Hybrid Electric Vehicles", WILEY, First Edition, 2018
- Tariq Muneer and Irene Illescas Garcia, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, Second Edition, 2017

Reference Book:

- RONALD K. JURGEN, "Automotive Electronics Handbook", Mc Graw Hill, Second Edition,1999
- Sheldon S. Williamson, 'Energy Management Strategies for Electric and Plug- I Hybrid Electric Vehicles", Springer, First Edition, 2013
- James Laminae and John Lowry, "Electric Vehicle Technology", John Wiley &6 Sons, Ltd, First Edition, 2003

(ET -22001) Mobile Communication

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Explain the concepts of cellular system, mobility, multiple access and the supporting technologies
2. Apply concepts of GSM and CDMA technologies to understand design of the higher generation technologies like 4G, 5G
3. Compare performance of various higher generation and latest technologies towards their usage as per user demands
4. Analyse radio propagation in wireless systems with understanding of different indoor and outdoor propagation models related to diverse types of fading, path loss models

Unit 1 **(5 hrs)**

Cellular Concept: System Design Fundamentals: Cellular system design, Frequency reuse, Co channel and adjacent channel interference, Interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment techniques, Improving the capacity of cellular system and related design problems, concepts of cell splitting, handover concepts in cellular system.

Unit 2 **(8 hrs)**

GSM Architecture and Interfaces: Introduction to GSM subsystems, GSM architecture, details of following blocks in GSM (Mobile station, Base station systems, Switching subsystems, Home location registers, Visiting location registers, Equipment identity register, Echo canceller), GSM Interfaces, GSM Logical Channels importance, Data Encryption in GSM, Mobility Management, Call Flows in GSM, Spectral efficiency calculations with multiple access technologies like TDMA, FDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and applications.

Unit 3 **(6 hrs)**

Code Division Multiple Access: CDMA technology, RAKE receiver, IS 95 system Architecture, Air Interface, Forward Link, Reverse link, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Comparison of GSM and CDMA technology, Spectral efficiency calculations for CDMA, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels, 3G system example WCDMA.

Unit 4 **(9 hrs)**

Mobile Radio Propagation: Concept of large-scale path losses and small-scale fading.
Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings
Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small-Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

Unit 5 **(10 hrs)**

Higher Generation Cellular Standards: Evolution of 2.5 G to 4G standards, supporting technologies, GPRS Architecture and node functionalities, Changes in N/W architecture from 2G to 2.5G, GPRS Interfaces, Identifiers, Logical and Physical channels, GPRS Call setup procedures – Attach/Detach/PDP context/LA-RA Update, GPRS services 2.75 G Standards: EDGE, 3G Network Architecture, Changes in N/W architecture, 3G Services. Limitation of 3G and motivation for 4G, 3G to 4G Evolution path, Changes in N/W arch from 3G to 4G, 4G Introduction and vision, LTE enabler Technologies: OFDMA, SC-FDMA, MIMO etc. Adaptive multiple antenna techniques, radio resource management, QOS requirements for 4G. LTE Network architecture, interfaces and node functionalities, LTE identifiers, LTE Services, LTE Protocol stack, Logical, Physical and Transport Channels, LTE Call Procedures

Unit 6 **(4 hrs)**

Introduction to 5G: Drivers for 5G, 5G Roadmap and Vision, 5G Enabler technologies, Key building Blocks (High Level View), 5G current state and development, Recent Trends in Telecommunication domain

Text books:

- Vijay K. Garg, "Wireless Communication and Networking", Elsevier, Morgan Kaufmann, Reprinted 2012.
- Vijay K. Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, Fifth Impression 2008.
- Vijay K. Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, Fourth Impression 2009.
- T.S.Rappaport, "Wireless Communications Principles and Practice", PHI, II Edition, 2006.

Reference Books:

- T L Singal, "Wireless Communications",Tata McGraw Hill, 2010
- William C.Y. Lee, "Mobile Cellular Telecommunication system", Tata McGraw Hill, II Editionc, 2008.
- Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons, 2015

(ET-22002) Embedded System Design

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Test I – 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Define embedded system design considerations.
2. Use ARM programming model for application development.
3. Interface peripheral devices with ARM processor.
4. Analyze the design aspects and architectural cosiderations of embedded systems using ARM.

Unit 1 **(4 hrs)**

Introduction to Embedded System: Embedded system overview, An Introduction to Embedded System Architecture, Embedded System Model, Design challenge, Processor Technology, IC Technology.

Unit 2 **(6 hrs)**

Embedded system Design and development process: System Design and Development, Life Cycle Models, The Design Process, formulating the requirement specifications, functional design, architectural design.

Unit 3 **(8 hrs)**

Introduction to ARM Architecture: Types of computer Architectures, ISA's and ARM History. Embedded System Software and Hardware, Endianness. Processor core VS CPU

core, Operational Modes. Instruction Format, ARM 3 stage Pipeline, ARM family attribute comparison. ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution.

Unit 4 **(10 hrs)**

Programmer's Model: ARM Instruction Set, Load Store Instruction, Software Interrupt Instructions, Branch Instructions, Data Processing Instructions, Coprocessor Instruction, Program Status Register Instructions, Loading Constants ,Conditional Execution, Addressing Modes, Thumb Instruction Set, Data Processing Instruction, Single Register Load-Store Instruction, Multiple Register Load-Store Instruction, Stack Instructions , interfacing peripheral with ARM**,** interrupt structure, An Overview of Embedded Development Environment for ARM, Cross Development Environment, Simulator, Software Emulator.

Text Book:

- Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley)
- Embedded Systems-A contemporary Design tool, James K Peckol, John Weily India Pvt Ltd,2008.

Reference Book:

- Raj Kamal, "Embedded systems: architecture, programming and design" Tata McGraw-Hill Education, 2003
- ARM System Developer's Guide: Designing and Optimizing System Software By Andrew Sloss,Dominic Symes,Chris Wright,May 2004 Elsevier

(ET-22003) Deep Learning and Edge Intelligence

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Design and implement FCNN models for applications such as classification and regression using ML/DL platform.
2. Apply regularization techniques for improving the model performance on validation/test datasets.
3. Design and/or select CNNs for various computer vision applications.
4. Apply and analyze RNNs for various applications that involve temporal/sequence learning tasks.5
5. Deploy ML/DL models designed for vision and sequence learning applications on edge platforms.

Unit 1 **(4 hrs)**

Artificial Neural Networks (ANN)

Introduction, Perceptron Training Rule, Sigmoid neuron, fully connected neural network, Activation functions, Loss functions for regression and classification, Gradient Descent and Backpropagation, Batch and mini-batch processing, Stochastic Gradient Descent

Unit 2 **(4 hrs)**

Regularization Techniques

Optimization and Regularization: Overfitting, Cross-Validation, Feature Selection, Regularization (L2 penalty, dropout, ensembles, data augmentation techniques) Hyperparameter tunning

Unit 3 **(4 hrs)**

Convolutional Neural Networks (CNN)

Convolutional Neural Network, Weight Initialization, Visualizing filters of a CNN, Guided Backpropagation, Autoencoders, Regularization in autoencoders, Denoising Autoencoders, Standard CNN models such as Alexnet, VGG net, Inception net, Resnet.

Unit 4 **(4 hrs)**

Recurrent neural networks (RNN)

Recurrent neural networks, sequence modelling, backpropagation through time; Hyperparameters, Vanishing/exploding gradient problem, Gradient clipping, Long-short term memory (LSTM)

Unit 5 **(6 hrs)**

Edge Devices and Networking

Edge computing, Advantages, Technologies involved in Edge development, Internet web and Networking technologies, Infrastructure, Role of M2M in Edge Intelligence, Overview of supported Hardware like NVIDIA Jetson Nano, TX2, Xavier NX Developer boards

Unit 6 **(6 hrs)**

Edge AI Solution

Model design with a focus on a reduced number of parameters, Efficient DNNs such as Squeeze net, Neural architecture search (NAS), Model compression: Lowering precision and fewer weights (pruning), post-training quantization tools e.g., TensorFlow Lite, Device consideration for deploying ML/DL algorithms, Ways of balancing model architecture (accuracy, size, operation type) requirements with device programmability, throughput, power consumption, and cost.

Textbooks:

- Bishop Christopher, "Neural Networks for Pattern Recognition", New York, NY: Oxford University, Press, ISBN: 9780198538646

Reference books:

- Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville published by MIT Press, 2016, ISBN: 9780262035613
- Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
- Online references for edge computing and intelligence
- Online references at www.tensorflow.org, www.pytorch.org

(ET-22004) Mobile Communication Lab

Teaching Scheme
Practical: 2 hrs./week

Examination Scheme
Term work - 50 Marks
Practical – 50 marks

Course Outcomes:

At the end of the laboratory work, students will demonstrate the ability to

1. Explain GSM handset working by detail section study and fault analysis using keyboard, display, battery, SIM, User Interface section
2. Apply knowledge of GSM AT commands for different applications and 3G system features using hardware platform and Proteus software
3. Analyse effect on CDMA performance by varying different types of PN codes, chip rate, spreading factor, processing gain
4. Develop awareness of system design using Software defined Radio and open-source simulator platform GNU radio.

List of Experiments:

1. Understanding Cellular Fundamentals like Frequency Reuse, Architecture, Interference, Path Environment, Coverage and Capacity using wireless communication software.
2. Knowing GSM and CDMA Network concepts like Call Management, Call Setup, call release, Handover, GSM Security and Power Control, Handoff Process, Rake Receiver, Capacity of CDMA using wireless communication software.
3. Study of GSM handset for various signalling conditions, to study transmitters and receiver section in mobile handset and measure frequency band signal and GMSK signal by observing signals at different test points.
4. To study and observe system blocks/ sections in GSM handset like: clock, SIM card, charging, LCD module, Keyboard, UI (User interface circuit) and observe the effect of fault insertion techniques.
5. To study various GSM AT Commands and understand its usages, different UI features, Understating of 3G Communication System with features like; transmission of voice and video calls, SMS, MMS, TCP/IP, HTTP, GPS and File system in 3G network.
6. To learn and develop concepts of AT command using Proteus software:
   - Interface GSM 900 modem to serial monitor and get the output of commands

- Interface GSM 900 modem to Arduino and make communication between them and see the output of serial monitor and see the output of different commands
- Interface GSM 900 modem ro serial monitor and perform the send & received SMS command

7. Study of direct sequence spread spectrum (DSSS) technique for CDMA, observe effect on performance of CDMA with variation of types of PN codes, chip rate, spreading factor, processing gain.
8. To design any one of the following using GNU radio:
   - Implementation of AM Transmitter and Receiver
   - Implementation of Narrow band FM Transmitter and Receiver
   - Implementation of SSB Transmitter and Receiver
   - Implementation of BPSK transmitter and Receiver
   - Design of Low pass filter with particular cut off frequency
   - Design of high pass filter with particular cut off frequency
   - Design of band pass filter with two different cut off frequencies
9. To Study 4G kit and its different sections in detail and observe the effect of fault insertion techniques.
10. To study various AT Commands on 4G kit and understand its usages, different User Interface features

(ET-22005) Embedded System Design Lab

Teaching Scheme
Practical: 2 hrs./week

Examination Scheme
Term work - 50 Marks
Practical – 50 marks

Course Outcomes:
At the end of the laboratory work, students will demonstrate the ability to

1. Develop programming skills for embedded system design.
2. Interfacing of peripheral devices.
3. Design an embedded system application.

List of Experiments:

a) Study of ARM evaluation board and IDE.
b) Interfacing of LED and switch.
c) Write a program for interfacing of ADC with ARM
d) Write a program for interfacing of DAC with ARM
e) Write a program for interfacing real time clock
f) Interfacing of keyboard and LCD.
g) Write a program for interfacing of temperature sensor
h) Application development – A case Study of embedded system

(ET-22006) Deep Learning and Edge Intelligence Lab

Teaching Scheme
Practical: 2 hrs./week

Examination Scheme
Term work - 50 Marks
Practical/Oral – 50 marks

Course Outcomes:

At the end of the laboratory work, students will demonstrate the ability to

1. Design and interpret the functioning of Deep Learning models, namely with CNN & RNN
2. Develop Classification and Regression applications to categorize and predict on test data samples.
3. Design and develop various AI applications using NVIDIA Jetson Nano /Raspberry-Pi and their various sensor interfacing
4. Analyze and evaluate the deployment of edge devices in the modern AI world.

List of Experiments:

1. Implement the gradient descent algorithm for a three-stage fully connected neural network using python and basic packages such as NumPy and matplotlib.
2. Implement Deep Neural Network for classification and regression tasks such as complex human activity recognition (HAR), temperature forecasting, etc.
3. Apply and Implement Deep Convolutional Neural Network (DCNN) architectures for object detection and classification.
4. Implement twitter spam detection using natural language processing by Autoencoder model.
5. Implement U-NET architecture for robust lungs segmentation in chest X-rays.
6. Implement anomaly activity detection through videos using RNNs and their variants.
7. Apply and Implement handwritten Text Recognition with TensorFlow using Deep Learning.

   Project List: Choose any One
8. Develop an Application on NVIDIA Jetson Nano /Raspberry-Pi to capture the values of temperature sensor after every 15 sec of time interval, store these values in .csv format and predict the temperature at particular time t using linear regression analysis.
9. Develop an Application on NVIDIA Jetson Nano /Raspberry-Pi for Object Recognition based smart AI BoT
10. Develop an Application on NVIDIA Jetson Nano /Raspberry-Pi for Smart Agriculture

Sem - VIII

[ET(DE)-22004] Embedded Software and RTOS

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Describe structure and working of real-time operating systems.
2. Apply the concept of task management & synchronization in real time system development.
3. Analyse the mechanisms adopted for inter task communication in multitasking environment.
4. Build and interpret embedded software design using RTOS concepts.

Unit 1 **(6 hrs)**

RTOS Concepts: Foreground and background systems, Critical section, Shared Resources, Tasks, Multitasking, Context Switching, Kernels, Pre-emptive and non-pre-emptive Schedulers, Static and Dynamic Priorities, Priority Inversion, Mutual exclusion, Synchronization, Inter task communication mechanisms, Interrupts: Latency, Response and recovery, Clock Tick, Memory Requirements.

Unit 2 **(6 hrs)**

Structure of μCOS-II: Kernel Structure, Tasks, Task States, TCB, Ready List, Task Scheduling, Task Level Context Switching, Locking and unlocking of a scheduler, Idle Task, Statistics Task, Interrupts, Clock Tick, Initialization, Starting the OS.

Unit 3 **(8 hrs)**

Task Management: Creating/ Deleting and Suspending/ Resuming Tasks, Task Stacks and checking, Changing Task's Priority. Time Management: Delaying/Resuming Task, System Time. Event Control Blocks: Initialization of ECB, Placing/Removing Task from ECB waitlist, Finding Highest Priority Task, List of Free ECB, Task State Management.

Unit 4 **(6 hrs)**

Synchronization in μCOS-II: Semaphore Management, Creation/Deletion, Pending /Posting / Acceptance / Query. Mutual Exclusion Semaphores: Creation/Deletion, Pending /Posting / Acceptance / Query Event Flag Management: Internals, Creation/Deletion of Event Flag groups, Waiting / Setting / Clearing / Looking for / Querying an Event Flag Group.

Unit 5 **(6 hrs)**

Communication in μCOS-II: Message Mailbox Management, Creating / Deleting a Mailbox, Waiting / Sending / Getting without waiting a Message from Mailbox, Status of Mailbox, Alternate uses of Mailbox, Message Queue Management: Creating / Deleting / Flushing a Message Queue, Waiting / Sending / Getting without waiting a Message from Queue, Status and Alternate use of Message Queue.

Unit 6 **(8 hrs)**

Porting of RTOS and application development: Memory Management, MCB, creating a partition, Obtaining / Returning / Waiting for a memory Block, Partition Status. Porting of μCOS-II Development Tools, explore RTOS features for the software development of embedded systems.

Textbooks:

- Raj Kamal, "Embedded Systems – Architecture: Programming and Design", Tata McGraw-Hill Education, 2003.
- Introduction to Embedded Systems, "Shibu K V", Tata McGraw Hill Education Pvt. Ltd.,2009.

Reference Book:

- Jean Labrosse, " MicroC/OS-II The Real Time Kernel", CMP Books , 2nd edition,2002.
- David E. Simon, "An Embedded Software Primer", Pearson India,1st Edition,2002

[ET(DE)-22005] Analog CMOS Design

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Interpret the graphical techniques for modelling Analog circuits and MOS transistor small geometry effects.
2. Design Analog sub circuits and cascaded stages for current and voltage gain, input and output impedances and frequency response.
3. Apply knowledge of analog sub circuits to design OP AMPS using basic compensation techniques.
4. Design and Evaluate Voltage reference circuits.
5. Design and Evaluate the performance of data converters.

Unit 1 **(4 hrs)**

Foundation: Analog Landscape, Right design Thinking, Techniques for intuitive and graphical understanding, understanding building blocks of analog circuits viz R, L, C and dependent V and I sources and their combinations, Large Signal Models of MOS Transistors: I-V Characteristics, Early Effect, Channel Length Modulation, Back Gate Effect and other Second-Order Effects.

Unit 2 **(8 hrs)**

Analog Sub-circuits: Single Stage Amplifier: CS stage with resistance load, Divide connected load, Current source load, Triode load, CS stage with source degeneration, Source follower, Common-gate stage, Cascade stage, Choice of device models.

Frequency response: CS stage, Source follower, Common gate stage, Cascade stage and difference pair, Noise analysis.

Unit 3 **(8 hrs)**

Differential Amplifiers: Basic difference pair, Common mode response, Differential pair with MOS loads, Gilbert cell. Cascade current mirrors, Active current mirrors.

Operational amplifiers design: One stage OPAMP, two stage OPAMP, Gain boosting, Slew rate, PSRR. Design equations and procedure

Unit 4 **(8 hrs)**

Basic Compensation techniques: Compensation of 2 stage OPAMP, Other compensation techniques.

Advanced OPAMP: Cascode and folded cascode op-amps, common mode feedback techniques.

Unit 5 **(6 hrs)**

Voltage References: Basic Design and Evaluation of Band Gap Reference, and CMOS Band Gap References MOS

Switched Capacitor circuits: Basic Switched Capacitor Integrators, Z-transforms, Switched Capacitor Filter Design, MOSFETC Filters

Unit 6 **(8 hrs)**

Introduction to data converters: Digital-to-Analog and analog to digital converters specifications understanding, Current scaling DAC, Voltage scaling DAC charge scaling DAC, extending resolution of parallel DAC, similar scaled DACs High speed ADCS, parallel or flash ADCS, interpolating ADCS, folding ADCS, Multi-bit pipeline ADCS delta sigma modular, Decimators filters

Textbooks:

- Athanasios PaBehzad Razavi,"Design of Analog CMOS Integrated Circuits", Tata Mc Graw-Hill, 2nd edition, 2018.
- Allen Holberg,"CMOS analog Circuit Design", Oxford University Press, 3rd edition, 2017 .

Reference Book:

- Mohammed Ismail, Terri Fiez, " Analog VLSI: Signal and Information Processing",Mc Graw Hill International Editions, 1st edition, 1993.
- Roubik Gregorian, Gabor C. Temes, "Analog MOS Integrated Circuits for Signal Processing", Wiley series on filters, 1st edition, 1986.
- Gray Hurst Lewis,"Analysis and Design of Analog Integrated Circuits", John Wiley and Sons, Fourth Edition, 2001

[ET(DE)-22006] Microwave and Radar

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Calculate the cut off wavelength, cut off frequency, group and phase velocity of the given rectangular waveguide.
2. Compare the features of rectangular and circular waveguide for given parameters.
3. Design microwave components such as power dividers, hybrid junctions, microwave filters and ferrite devices.
4. Explain the basic concepts, types, working of radar.
5. Analyse and design simple radar systems and the associated signal processing, at block diagram level.
6. Implement simple microwave and RADAR based communication system and will be in a position to understand the developments in the technology of advanced communication.

Unit 1 **(8 hrs)**

Fundamentals of Microwaves and Waveguides: Microwave band designations, Advantages, applications and hazards of Microwaves, Propagation of microwave rectangular waveguides, TE and TM modes, Guide wavelength, Group and Phase Velocity, Power losses and power handling capacity of rectangular waveguide, Circular waveguides, Cavity Resonators.

Unit 2 **(8 hrs)**

Microwave Passive Components: Scattering Parameters, Microwave junctions – E-Plane, H-Plane, Magic TEE and Rat race ring, Directional Couplers, Ferrite devices – Isolator, Circulator and Gyrator, Microwave Filters, Microwave Antennas – Horn and Dish.

Unit 3 **(8 hrs)**

Microwave Active Components: Microwave Tubes - Klystron and Magnetron, Slow wave devices – Helix TWT, Solid state microwave devices – Transferred Electron Devices (TED): Gunn diode, Varactor diodes, Avalanche Transit time devices: READ diode, IMPATT diode and BARITT diode, other diodes - PIN diode, Tunnel (Esaki) diode with their applications as an oscillator and an amplifier.

Unit 4 **(6 hrs)**

RADAR Fundamentals: Basic block diagram of RADAR, RADAR performance factors – RADAR range equation, factors influencing range, effect of noise. Basic pulse RADAR, Scanning, Tracking.

Unit 5 **(6 hrs)**

RADAR Systems: Doppler effect, CW Doppler RADAR, FM CW RADAR, MTI, Display methods.

Unit 6 **(6 hrs)**

Microwave and RADAR Based Communication Systems: Analog Microwave Communication, Satellite Communication, Digital Microwave Communication.

Textbooks:

- Kulkarni M, "Microwave and Radar Engineering", 4th Edition, Umesh Publications, 2012.
- Skolnik, Merrill Ivan. "Introduction to radar systems." SIE, 2017.

Reference Book:

- Samuel Y. Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson Education, 2003.
- David M. Pozar , Microwave Engineering, 4th Edition, Wiley India, 2012.
- Robert E. Collin, Foundation of Microwave Engineering, 2nd Edition, Wiley India, 2012.

[ET(DE)-22007] Biomedical Engineering

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Explain the origin of bio-potentials and various electrodes for sensing and conditioning bio signals.
2. Analyse the human cardio- vascular, central nervous and muscular system and explain the different measurement techniques for the signals originating from these systems.
3. Apply image processing principles in imaging techniques such as X-rays, image intensifiers, CT scanners, ultrasound scanners and MRI.
4. Select suitable transducers for medical applications.
5. Classify and select suitable biomaterials for artificial organs/ implants

Unit 1 **(6 hrs)**

Cell structure, basic cell functions, origin of bio-potentials, electrical activity of cells, Acquisition, types of bio-signals, Study of diagnostically significant bio-signal parameters, Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface

Unit 2 **(8 hrs)**

Cardio-vascular system and measurements: Structure of heart, rhythmicity, pacemaker cell filters, averaging and integrator circuits, ECG signal acquisition, ECG electrodes, electrocardiograph, vector cardiograph, ECG analysis, ECG- QRS detection, R amplitude, interval detection, Bio-signal amplifiers and signal processing, transient protection, isolation circuit, Phonocardiography, PCG analysis to diagnose heart valve disorder, blood pressure measurement (invasive and non-invasive), blood flow meter-magnetic and ultrasound, cardiac output measurement, Plethysmography, Short wave diathermy, microwave diathermy, ultrasound therapy unit, transcutaneous electrical nerve stimulators, radiotherapy, Pacemakers and defibrillators, heart lung machine.

Unit 3 **(8 hrs)**

Central nervous systems and muscular system: Receptors, sensory pathways and motor systems, processing sensory information, neural, neuromuscular, sensory muscular and sensory measurements, biofeedback, evoked response, Electroencephalography (EEG), EEG amplifier, separation of alpha, beta, theta and delta waves from EEG. Classification of muscles – muscle contraction mechanism, myoelectric voltages, Electromyography (EMG), noise removal and signal compensation for reducing ECG artefacts in an EMG recording.

Unit 4 **(6 hrs)**

Auditory and vision system: Mechanism of hearing, sound conduction system, basic audiometer, pure tone audiometer, Evoked response audiometer system, hearing aids.
Anatomy of eye, visual acuity, slit lamp, tonometer, ophthalmoscope, perimeter, LASER applications in ophthalmology – diabetic retinopathy, glaucoma and retinal hole and detachment treatment.

Unit 5 **(4 hrs)**

Introduction to image processing. Imaging systems X-rays, image intensifiers, CT scanner, ultrasound scanner, nuclear methods, thermography, MRI, fusion imaging

Unit 6 **(8 hrs)**

Sensors and Bio-materials: Transducers for biomedical applications: Force and pressure transducers: such as piezoelectric, strain gauge, Displacement transducers, Bio potential Electrodes, Transducers for cardiovascular measurement, Transducers for heart sound measurement, Transducers for Non-invasive diagnostic measurements.
Introduction to Biomaterials: Biocompatibility, metallic, ceramics, polymers, composite materials, biodegradable polymeric material, biologic biomaterials, interactions of materials with the human body: concepts and applications, Case study: Bionic eye and ear

Textbooks:

- Leslie Cromwell, Fred J. Weibull, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Pearson Education, 2nd edition, 1980.
- R. S. Khandpur, "Handbook of Biomedical Instrumentation", TMH, 2nd edition, 200

Reference Book:

- Vander, Shermen, "Human Physiology– The Mechanism of Body Functions", TMH, 13th edition, 2013.
- Tompkins, "Biomedical Digital Signal Processing", PHI, 5th edition, 2010.
- John G Webster, "Encyclopaedia of Medical Devices and Instruments", Wiley Publications, 1988.
- M. Arumugam, "Biomedical Instrumentation", Amerada Publishers, 2nd edition,1992.
- Carr and Brown ,"Introduction to Biomedical Equipment Technology", Pearson LPE, 4th edition, 2001.
- Richard Aston, "Principles of Biomedical Instrumentation and Measurement", Maxwell Macmillan International, edition, 1990.
- John G. Webster, "Medical Instrumentation Application and Design", John Wiley& Sons Pvt. Ltd, 3rd edition, 2009

[ET(DE)-22008] VLSI Design and Verification

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I – 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Interpret verification techniques and create reusable verification environment.
2. Verify increasingly complex designs more efficiently.
3. Apply the concepts of testing to get a better yield in IC design
4. Apply verification techniques using EDA tools.

Unit 1 **(4 hrs)**
Verification guidelines: Basic Testbench functionality, directed testing, Verification Process, Testbench components, Constrained-Random stimulus, Functional coverage, Building layered testbench, Simulation environment phases, Maximum code reuse, Testbench performance.

Unit 2 **(6 hrs)**
System Verilog Constructs: Data types: Built-in data types, Fixed-size arrays, Dynamic arrays, Queues, Associative arrays, Array methods, choosing a storage type, creating new types with typedef, Type conversion, Enumerated types, Constants strings, Expression width**.**

Unit 3 **(8 hrs)**
Procedural Blocks: Fork Join, Tasks and Functions, Inter Process Communication (Semaphore mailbox), Interface: ports, clocking blocks, virtual interface, Top-level Program – Module interactions.

Unit 4 **(6 hrs)**
Basic OOPs: Inheritance, Polymorphism
Randomization: Randomization and constrained Randomization rerandomize and post randomize functions, Random number generators

Unit 5 **(8 hrs)**
Functional coverage: Cover group, cover points, Bins

Unit 6 **(8 hrs)**
System Verilog Assertions: Properties, Boolean expressions
Assignments: Apply the concepts of system Verilog constructs to verify DUTs of:
1. ALU
2. FIFO
3. Ethernet
4. AMBA protocol

Textbooks:

- Chris Spears, " System Verilog for Verification", Springer, 2nd Edition
- IEEE 1800-2009 standard (IEEE Standard for SystemVerilog— Unified Hardware Design, Specification and Verification Language).
- System Verilog website – www.systemverilog.org

Reference books:

- http://www.sunburstdesign.com/papers/CummingsSNUG2006Boston_SystemVerilog_Events.pdf
- General reuse information and resources: www.design-reuse.com, www.verificationacademy.com
- OVM, UVM(on top of SV)
- Verification IP resources: http://www.cadence.com/products/fv/verification_ip/pages/default.aspx
- http://www.synopsys.com/Tools/Verification/FunctionalVerification/VerificationIP/Pages/defau lt.as

[ET(DE)-22009] Natural Language Processing

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Describe the fundamental concepts and techniques of natural language processing
2. Apply Language modeling techniques like N-Gram and Neural Language Model.
3. Apply the appropriate processing techniques to various NLP a problem.
4. Analyze large volume text data generated from a range of real-world applications.

Unit 1 **(4 hrs)**

Speech: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Unit 2 **(8 hrs)**

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Unit 3 **(8 hrs)**

Language Modelling: N-gram and Neural Language Models Language Modelling with N-gram, Simple N-gram models, smoothing (basic techniques), Evaluating language models; Neural

Network basics, Training; Neural Language Model, Case study: application of neural language model in NLP system development

Unit 4 **(8 hrs)**

Structures: Theories of Parsing, parsing algorithms, rule-based and probabilistic Parsing, scope ambiguity, and attachment ambiguity resolution

Unit 5 **(6 hrs)**

Distributional Models of Semantics, Word Embeddings, Lexical Semantics, Topic Models, Entity Linking, Information Extraction.

Unit 6 **(8 hrs)**

Applications: Text Summarization, Text to speech, Sentiment Analysis, and Opinion Mining, Language translation, Smart assistants, and chatbots

Textbook

- Deepti Chopra, Jacob Perkins, and Nitin Hardeniya, Natural Language Processing: Python and NLTK, 2016.
- Dipanjan Sarkar, Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data, Apress,2016.

Reference Book:

- Daniel Jurafsky and James H. Martin. 2020. Speech and Language Processing. 3rd Edition
- Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural Language Processing. MIT Press.
- Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana. 2020. Practical Natural Language Processing. O'Reilly.
- Hobson Lane, Cole Howard, Hannes Hapke. 2019. Natural Language Processing

[ET-22007] Project

Teaching Scheme
Practical - 16 hrs./week

Examination Scheme
Term-work: 50 Marks
Oral: 50 Marks

Course Outcomes:
At the end of the laboratory work, students will demonstrate the ability to

1. Identify a problem statement from a rigorous literature survey or the industry requirements analysis.
2. Simulate and design a solution for the identified problem by applying acquired technical knowledge.
3. Develop and test the prototype/algorithm to solve the complex engineering problem.
4. Accomplish all objectives of the project in allocated period with efficient teamwork.
5. Demonstrate an ability to present project work through a comprehensive report and project presentation.
6. Demonstrate professional ethics and values by solving engineering problems to benefit society or industry.

Guidelines: After interactions with project guides/industry experts, based on a comprehensive literature survey/ Industry requirements analysis, the student shall identify the title and define the aim and objectives of a project.
The student is expected to work on details specifications, methodology, resources required, critical issues in design and implementation, and submit the project proposal within the first two weeks of semester.The student is expected to work on the design, development, and testing of the proposed project work as per the schedule.

Deliverables: The project report is to be submitted at the end of the semester. This report includes a summary of the literature survey, detailed objectives, project specifications, design, proof of concept, developed system/Algorithm, results, contributions, and innovations in project work.

Evaluation: A committee comprising of guide and internal evaluation panel members shall assess the progress at mid-semester. Guide and appointed external examiner shall assess the progress/performance of the student based on a report, project presentation, and Q & A. This evaluation will be conducted at the end of the semester.

Scheme B (Sem - VIII)

(ET-22008) Internship and Project (Industry/Corporate/Academia)

Teaching Scheme
Practical in Industrial/Corporate/Academia: 20 hrs/week

Examination Scheme
Term work - 50
Oral - 50

Course Outcomes:
At the end of the work, students will demonstrate the ability to

1. Explain the basic concepts of assigned internship work and Undertake problem identification, formulation and solution.
2. Implement work plan in their Industrial In-Plant Training Project work.
3. Identify a problem statement from the industry requirements analysis.
4. Simulate and Design a solution for the identified problem by applying acquired technical knowledge.
5. Develop and test the prototype/algorithm to solve the complex engineering problem.
6. Demonstrate an ability to presentproject work through a comprehensive report and project presentation.
7. Accomplish all the objectives of the project, resulting in at least a thesis publication, and research outputs in terms of publications in high impact factor journals, conference proceedings, and patents.
8. Demonstrate professional ethics and values by solving engineering problems for the benifite of the industry and society.

1. **Project Identification -** Idea Screening, Project Appraisal, Project Selection. Perform a literature search to review current knowledge and developments in the chosen technical area.
2. **Project Planning/Development of Project Network -** Work Breakdown Structure, Project Scheduling, Project Scheduling with Probabilistic Activity Times, Resource Considerations in Projects.
3. **Implementation Methodology -** Undertake detailed technical work in the chosen area using one or more of theoretical studies, computer simulations and hardware development.
4. **Results Analysis and Discussion -** Formulate the results obtained and discuss comparative analysis of secure results.
5. **Conclusion and Future Directions -** Prepare a formal report describing the work undertaken and results obtained so far; and Present the work in a forum involving poster presentations and demonstrations of operational hardware and software.

Honors Courses in E&TC

Sem-VII

(ET(HO)-22001) Cognitive Radio

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Explain the fundamental concepts of cognitive radio networks.
2. Design the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
3. Describe technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
4. Describe the fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a few optimization techniques for better spectrum exploitation

Unit 1 **(4 hrs)**

Radio resource management in wireless networks: Overview of Wireless networks considering their spectrum usage, Radio frequency bands and spectrum management, (RRM) framework, Next generation heterogeneous wireless access networks and cognitive radio

Unit 2 **(8 hrs)**

Introduction to Cognitive Radio: Spectrum hole/spectrum opportunity, Software-defined radio, Cognitive radio features and capabilities, Cognitive radio architecture, Functions of cognitive radio, Components of cognitive radio, Potential applications of cognitive radio

Unit 3 **(8 hrs)**

Spectrum Sensing: Detection of spectrum holes, Practical spectrum sensing approaches: Non- Cooperative Sensing, Cooperative Sensing, collaborative sensing using relay transmission, Replacement of sensing devices in secondary users, New cognitive cycle with separate sensing devices, Maximum likelihood estimator, Maximum a posteriori (MAP)/Bayesian estimator

Unit 4 **(8 hrs)**

Dynamic spectrum access: Spectrum access models, Dynamic spectrum access architecture, Open issues in dynamic spectrum access, Distributed dynamic spectrum access: learning algorithms and protocols

Unit 5 **(6 hrs)**

Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

Unit 6 **(8 hrs)**

Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross-layer design for cognitive radio networks, Cognitive radio architectures for Next Generation (XG) networks, Cognitive radio standardization

Textbooks:

- Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
- Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
- Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.

Reference:

- Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer.
- Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems", Springer, 2009.
- Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press,

Sem-VIII
[ET(HO)-22002] Software Defined Networks

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Explain advanced concepts in Programmable Networks
2. Interpret Software Defined Networking, an emerging Internet architectural framework.
3. Implement the main concepts, architectures, algorithms, protocols and applications in SDN and NFV

Unit 1 **(4 hrs)**

Programmable Networks: Introduction to Programmable Networks, Programmable Networking Model, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Active Networking

Unit 2 **(8 hrs)**

Software Defined Networks: Definition, Benefits, and Challenges, Comparisons Between Sdn and Conventional Networking, SDN Reference Model, Separation of Control Plane and Data Plane, Advantages and Disadvantages of separating control and data planes

Unit 3 **(8 hrs)**

Architecture of SDN: Infrastructure Layer: Switching Device Model, Research challenges, Control Layer: Controller Logical Design, Control Layer Performance, Application Layer: Functions and research challenges, OpenFlow Protocols and its versions

Unit 4 **(8 hrs)**

Controllers and Languages for SDN: SDN Controllers including Floodlight, Open Daylight and POX controllers, Comparative analysis of controllers, High Level Languages for SDN: Flow-based Management Language, Frenetic, Pyretic, Nettle, Maple

Unit5 **(6 hrs)**

Network Virtualization: Concepts, Applications, Introduction to Mininet: Simulation environment for SDN, Installation of Mininet, Topology Generation, Miniedit use.

Unit 6 **(8 hrs)**

Network Functions Virtualization (NFV): Definition, Benefits, NFV architecture, Comparison between NFV and SDN, Case studies: Data Centres, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

Textbooks:

- Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", O'Reilly Media, August 2013.
- Paul Goransson, Chuck Black, Timothy Culver. "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann Publishers, 2016.
- Fei Hu, "Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, 2014
- Vivek Tiwari, "SDN and OpenFlow for Beginners", Amazon Digital Services, Inc., ASIN: , 2013.

Reference Book:

- Nick Feamster, Jennifer Rexford and Ellen Zegura, "The Road to SDN: An Intellectual History of Programmable Networks" ACM CCR April 2014.
- Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015.
- OpenFlow standards, http://www.openflow.org, 2015.
- Vivek Tiwari, "SDN and Openflow for beginners with hands on Labs", M.M. Multimedia LLC. Northville, MI.

Minor Courses in IoT
Sem-VII

(ET (MI)-22001) Digitalization and IoT Applications

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to

1. Identify the need and system requirement of IoT technologies for today's application scenarios.
2. Explain the types of technologies that are available and in use today and can be utilized to implement IoT solutions.
3. Apply these technologies to tackle scenarios in terms of using an experimental platform for implementing prototypes for the applications.
4. Design complete IoT system for any one case study.

Unit 1 **(6 hrs)**

Introduction to Digitization: Impact of digitization on products, services, process and business models, Digital Enabler Technologies for IoT.

Unit 2 **(6 hrs)**

Introduction to Internet of Things: Concepts, Terminology, components, characteristics, Requirements and Applications of IoT, Disambiguation- IoT, IoE, Industrial (4.0) IIoT, M2M etc.

Unit 3 **(8 hrs)**

IoT Enabling Technologies: Sensors, Actuators, Embedded platforms, Communication Protocols, Wireless Sensor Networks- Topology, Operating System, special features like energy saving. Big Data Analytics, Cloud Computing and AI/ML.

Unit 4 **(8 hrs)**

IoT platform design Methodology: Purpose and Requirements specification for IoT platform design, operational view specification, application development.

Unit 5 **(6 hrs)**

Internet of Things Privacy, Security and Governance: Introduction, Overview of Governance, Privacy and Security Issues, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities.

Unit 6 **(8 hrs)**

IoT Applications: Smart Home, Smart City - Smart Parking, smart transportation, smart grid and waste management. Environment - Weather monitoring system and Air pollution monitoring. Agriculture - Smart Irrigation using Drone. Health care – Telemedicine etc.

Textbooks:

- A Bahaga, V. Madisetti, "Internet of Things- Hands on approach", 1st Edition, VPT publisher, 2014.

Reference Book:

- Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. "Internet of Things: Principles and paradigms", Elsevier, 2016.
- Hassan, Qusay F., ed. "Internet of things A to Z: technologies and applications", John Wiley & Sons, 2018.
- Samuel Greenguard, "Internet of things", MIT Press.

Sem -VIII
[ET (MI)-22002] Cloud Computing and IoT Platforms

Teaching Scheme
Lectures: 3 hrs./week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Describe the IoT and Cloud architectures
2. Deploy Cloud Services using different cloud technologies.
3. Implement and establish cloud computing elements such as virtual machines, web apps, mobile services using data migration techniques.
4. Implement virtualization and availability optimization on the Cloud.

Unit 1 **(6 hrs)**

Introduction to IoT

Introduction to IoT and Digitization, IoT Architecture, Convergence of IT and IoT, Layers of IoT, Understanding IoT Components, IoT Network Architecture and Design, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Unit 2 **(8 hrs)**

Cloud Computing

Cloud Computing vs On-Premise Computing, Cloud Computing-Definition, Characteristics, Components, Software Virtualization, Containerizing applications, Virtual Machine Provisioning & Manageability, Cloud Deployment models, Cloud service models: PaaS, SaaS, IaaS

Unit 3 **(6 hrs)**

Introduction to IoT Platform

Cloud IoT Architecture, IoT Cloud Services, Identity & Device Management, Introduction to Dashboards & Web portals, Application development, and cloud processing.

Unit 4 **(6 hrs)**

Cloud Computing and Hosting IoT

Virtualization, Hypervisors to Create Virtual Machines, Serverless Computing, Managing Virtual Machines, Container Orchestration, Docker containers, and the Docker Hub

Unit 5 **(6 hrs)**

Cloud Networking Services

Introduction to AWS, Services offered by AWS like EC2, S3, Lambda etc., AWS IoT Core, Virtual Private Cloud Networking, High-Performance, Scalable Load Balancing, Cloud Computing and Service-Oriented Architecture (SOA)

Unit 6 **(8 hrs)**

IoT Applications using Cloud

Hands-on activities for at least one cloud service provider like AWS / Azure / Google Cloud, IoT Platforms – Enterprise-grade and Open source, Network Performance and Availability Optimization on the Cloud Cloud Security.

Textbooks:

- Internet of Things, 2ed, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Wiley, ISBN: 9788126578375
- Mastering Cloud Computing, 1st Edition, Foundations and Applications Programming, Rajkumar Buyya Christian VecchiolaS.ThamaraiSelvi, ISBN: 9780124095397
- Cloud Computing for Dummies by Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper (WileyIndia Edition)
- Enterprise Cloud Computing by Gautam Shroff,Cambridge University Press,2010, Online ISBN- 9780511778476.

Reference Book:

- William W. Hines, Douglas C. Montgomery, David M. Goldsman, Connie M. Borror, "Probability and Statistics in Engineering", Wiley, 4th Edition,2003
- Kumar Saurabh," Cloud Computing", Wiley India, 1st Edition, 2016.