Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

Syllabus for
Final Year B. Tech.
Electronics & Telecommunication
(Pattern 2017)

Department of
Electronics & Telecommunication
Engineering

VISION:

- Excellence in Electronics & Telecommunication Engineering Education

MISSION:

- Provide excellent blend of theory and practical knowledge
- Establish centre of excellence in post graduate studies and research
- Prepare engineering professionals with highest ethical values and a sense of responsible citizenship

Program Educational Objectives (PEO):

1. Graduates of the program will become competent electronic engineers suitable for industry.
2. Graduates of the program will apply the mathematical and analytical abilities gained through core courses of Electronics and Communication engineering.
3. Graduates of the program will apply problem solving skills to develop hardware and/or software.
4. Graduates of the program will become responsible citizen.

Program Outcomes (PO):

A graduate of the program will have

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **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.
4. **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.
5. **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.
6. **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.
7. **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.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **Project management and finance**: Demonstrate knowledge and understanding ofthe 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.
12. **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 (PSO):

Graduates will be able to

1. Apply and demonstrate the usage of hardware and software platforms for variety of applications.

2. Apply different mathematical and statistical methods for analysis and design of signal processing and communication systems.

Graduate attributes:

1. Engineering knowledge
2. Problem Analysis
3. Design/Development of Solutions
4. Investigations of Complex Problems
5. Modern Tool Usage
6. The Engineer and Society
7. Environment and sustainability
8. Ethics
9. Individual and Teamwork
10. Communication
11. Project management and Finance
12. Life –long Learning

FINAL YEAR B. TECH (E&TC ENGINEERING), SEMESTER VII (PATTERN 2017)
For Academic Year 2020-21

MODULE-I

Course Code	Course	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
ETUA40171	Embedded system and Operating System	TH	3	-	2	20	30	20	30	25	125	4
ETUA40172	Computer Networks and Security	TH	3	-	2	20	30	20	30	25	125	4
ETUA40173	Mobile Communication and Networks	TH	3	-	2	20	30	20	30	25	125	4
ETUA40174	Elective-III	TH	3	-	2	20	30	20	30	25	125	4
ETUA40175	Intellectual Property Rights	CE	2	-	-	-	-	50	-	-	50	2
ETUA40176	Project Work*	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
A4	Audit Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	-	18	180	120	130	120	150	700	23

Elective – III:

ETUA40174A: Deep Learning

ETUA40174B: Robotic Systems

ETUA40174C: Power Electronics for Electric Vehicles

ETUA40174D: Speech and Audio Processing / Business Intelligence

MODULE-II

Course Code	Course	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
ETUA40177	Semester Internship *	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
A4	Audit Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	24	100	-	-	-	50	150	12

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

BoS Chairman **Dean Academics** **Director**

FINAL YEAR B. TECH (E & TC ENGINEERING), SEMESTER VIII (PATTERN 2017)

MODULE-III

Course Code	Course	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
ETUA42171	Elective-IV	TH	3	-	2	20	30	20	30	25	125	4
IOEUA42172	Open Elective-I	TH	2	-	2	20	30	20	30	25	125	3
IOEUA42173	Open Elective-II	TH	3	-	-	20	30	20	30	-	100	3
ETUA42174	Introduction to Research	CE-PR/OR	1	-	2	-	-	-	-	25	25	2
A4	Audit course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	9	-	6	60	90	60	90	75	375	12

Elective-IV		**Open Elective-I**		**Open Elective-II**	
ETUA42171A	Image and Video Processing	IOEUA42172A	Introduction to Gaming	IOEUA42173A	FinTech (Financial Technology)
ETUA42171B	High Performance Computing	IOEUA42172B	Inferential Statistics for Data Science	IOEUA42173B	Agriculture Electronics
		IOEUA42172C	Solar and wind Energy	IOEUA42173C	Operation Research
ETUA42171C	Wireless Networks	IOEUA42172D	Numerical Methods in Engineering	IOEUA42173D	Total Quality Management
		IOEUA42172E	Social Media Analytics	IOEUA42173E	Blockchain Technology

MODULE-IV

Course Code	Course	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
ETUA40177	Semester Internship*	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
A4	Audit Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	24	100	-	-	-	50	150	12

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

FINAL YEAR B. TECH (E & TC ENGINEERING), SEMESTER VIII (PATTERN 2017)
MODULE-V

Course Code	Course	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
ETUA40171	Embedded system and Operating System	TH	3	-	2	20	30	20	30	25	150	4
ETUA40172	Computer Networks and Security	TH	3	-	2	20	30	20	30	25	150	4
ETUA40173	Mobile Communication and Networks	TH	3	-	2	20	30	20	30	25	100	4
ETUA40174	Elective-III	TH	3	-	2	20	30	20	30	25	100	4
ETUA40175	Intellectual Property Rights	CE	2	-	-	-	-	50	-	-	50	2
ETUA40176	Project Work	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
A4	Audit Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	-	18	180	120	130	120	150	700	23

Elective – III:

ETUA40174A: Deep Learning

ETUA40174B: Robotic Systems

ETUA40174C: Power Electronics for Electric vehicles

ETUA40174D: Speech and Audio processing / Business Intelligence

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

NOTE:
Students who will register for Module-I in Semester VII have to register either of Module-III or Module-IV in Semester VIII.
Students who will register for Module-II in Semester VII have to register for Module-V in Semester VIII.

BoS Chairman **Dean Academics** **Director**

Module – I & V

ETUA40171: Embedded system and Operating System

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2hr./week	20	30	20	30	-	25	125

Prerequisite: Readers/students are expected to know the following concepts:
Basics of system design,
C programming
Processor architecture

Course Objectives:

- To introduce techno commercial aspects and development tools for embedded system.
- To impart knowledge of OS and RTOS in specific.
- To develop implementation skill for application specific systems.
- To impart design aspects implementation of real time system using RTOS.
- To impart usage of open source OS(Linux) for embedded application.
- To impart the knowledge of design and development of embedded system through case studies.

Course Outcomes: On completion of the course, students will be able to

1. Identify techno commercial aspect of embedded system design
2. Understand various operating system services
3. Understand and Differentiate RTOS and GPOS w.r.t real time system
4. Design and Program embedded application using RTOS µcos-II.
5. Use Linux for embedded system development
6. Understand embedded system design components through case studies

Unit I: Embedded System Overview

Embedded System Introduction, Hardware and software architectures of ES, Design metrics (technical and techno- economical), Prototyping models, Development tool chain insights (GNU), guidelines for Selection of hardware and memory architecture, embedded C programming, embedded system design challenges, standard programming practices in embedded system.

Unit –II: Basics of OS

OS concept, services, structure, types, scheduling, task management. Context switching, timing services, inter-process communication and synchronization, memory management, device management, File management.

Unit III: Real time system and RTOS

Real time system, types, design approaches and considerations, Usage of Shared resources and related issues**,** Concept of RTOS, Types of RTOS, differences from GPOS (Multitasking, interposes communication, Timers, Device drivers, protection mechanism etc), real time scheduling algorithms, commercial RTOS , survey of RTOS.

Unit IV: µcos-II –RTOS

µcos-II features, kernel structure, data structure, µcos-II services as task management, time management, interprocess communication (mailbox, queue, events, pipes etc), memory management. Mcos-II porting on ARM7/Cortex (M3/M4) architecture

Unit V : Embedded Linux

Linux for embedded systems, embedded Linux development system, kernel architecture and configuration, file systems, porting Linux on ARM architecture, bootloaders, tool utilities such as Minicomp, Busybox, Redboot, Libc,
Device drivers- concept, architecture, types, sample character device driver

Unit VI: Case Study of real time system

1. Communication bridge
2. Automated real time control systems
3. ACC

Textbooks:

1. Frank Vahid and Tony Givargis, "Embedded System Design – A Unified hardware/ Software introduction" 3rd edition, Wiley
2. Jean Labrosse, "µcos-II, The Real-Time Kernel", 2nd edition, CMP Books.
3. Christopher Hallinan, "Embedded Linux Primer -A Practical, Real-World Approach "2nd edition, Prentice Hall.

Reference Books:

1. P. Ramesh Babu, "Digital Signal Processing", Fourth edition, Scitech Publication David Simon, "Embedded system primer"
2. Raj Kamal, "Embedded Systems – Architecture, Programming and Design" 2nd edition s.

List of Experiments:

1. Porting exercise of µcos-II on ARM7/Cortex M3 architecture
2. Demonstrate multitasking services of µcos-II on ARM7/ Cortex M3 platform.
3. Demonstrate inter-task communication services of µcos-II on ARM7/ Cortex M3 platform
4. Demonstrate time management services of µcos-II on ARM7/ Cortex M3 platform
5. Customizing Linux for embedded platform
6. Demonstrate application development with embedded Linux
7. Demonstrate device driver development with embedded Linux
8. Design and development of embedded application using µcos-II /embedded Linux

ETUA40172: Computer Networks and Security

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisite: Readers/students are expected to know the following concepts:

1. Data Communications, Topology, Networking, Network categories
2. Protocol layering, layers in OSI reference model, TCP / IP protocol suite, and Addressing,
3. Guided and Unguided Transmission media,
4. Switching: Circuit switched networks, Packet Switching.

Course Objectives:

- To understand state-of-the-art in network protocols, architectures, and applications
- To provide a theoretical and practical base in computer networks
- To outline the basic network configurations
- To understand fundamentals of VPN and ACS protocol.
- To understand security issues involved in LAN and Internet.

Course Outcomes: On completion of the course, student will be able to

1. Understand fundamental principles of computer networking
2. Describe switching and routing in the network and their interrelation.
3. Specify services and deficiencies in existing protocols, and use of new protocols.
4. Acquire the basic knowledge of network security.
5. Explain Virtual Private Network and Access Control Server Protocol
6. Identify security threats and understand use of Intrusion Detection and prevention System (IDS/ IPS)

Unit-I: Network Layer Protocol and Addressing

Network Layer Protocol: ARP, RARP, IGMP, IPv4, IPv6, ICMPv4, ICMPv6
IP Addressing: Classful and Classless Addressing

Unit-II: Switching and Routing

Switching: Frame, Hub, Bridge, Collision Domain, Broadcast Domain, Spanning Tree Protocol
Routing: RIP, OSPF, BGP, EIGRP

Unit-III: Protocol and Services

Transport layer: UDP, TCP, SCTP (Connection Oriented and Connectionless Protocol)
Application layer: WWW, HTTP/ HTTPS, SMTP, DNS, DHCP, FTP/ TFTP

Unit-IV: Introduction to Security

Security Basics - Confidentiality, Integrity, Availability
Intrusion Alert: Interruption, Interception, Modification, Fabrication
Introduction to Security Appliances (any three): CISCO, Juniper, etc.

Access Control List (ACL) and NAT

Unit-V: Virtual Private Network and Access Control Server Protocol
VPN: IPsec, SSL
ACS Protocol: Radius, TACACS, AAA

Unit-VI: Security Threats and Intrusion Detection System (IDS/ IPS)
Types of attack: Denial of service (DOS), backdoors and trapdoors, sniffing, spoofing, man in the middle, replay, TCP/IP Hacking, Phishing attacks, Distributed DOS, SQL Injection. Malware: Viruses, Logic bombs Intruders, Intrusion detection systems (IDS): host based IDS, network based IDS, logical components of IDS, signature based IDS, anomaly based IDS, network IDS components, advantages and disadvantages of NIDS, host based IDS components, advantages and disadvantages of HIDS.

Text Books:

1. Behrouz A. Foruzan, "Data communication and Networking", Tata McGraw-Hill,5th Edition
2. James F. Kurouse& W. Rouse, "Computer Networking: A Top down Approach", 6th Edition, Pearson Education.

Reference Books:

1. CCNA Security 200-300
2. Wayne Tomasi, "Introduction to Data Communication and Networking", 1/e, Pearson Education

List of Experiments:

1. Study of IP Addresses Subnetting and CIDR
2. Installation of Protocol/ Packet Analyzer Tool and analysis of Network Traffic
3. Assignment on LAN & WAN simulation using Network simulator Tool.
4. Installation and configuration of Web Server, FTP server Installation
5. Lab assignment on Switching and Routing (based on Spanning Tree Protocol)
6. Lab assignment based on VPN
7. Case studies on Security Threats and Intrusion Detection System (IDS/ IPS)

ETUA40173: Mobile Communication and Networks

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Basics of Analog Communication
Basics of Digital Communication
Basics of Networking

Course Objectives:
- To explain concepts of traffic engineering and network signaling
- To describe signal propagation in wireless medium and basics of cellular mobile communication
- To discuss fundamentals, Channels and Services of GSM system
- To understand evolution of 4G LTE and 5G technologies.

Course Outcomes: On completion of the course, students will be able to
1. Apply the concepts of traffic engineering for lost call and queuing systems, and understand the concepts of signaling
2. Interpret small scale, large scale and multipath fading and its effect on signal propagation in wireless medium
3. Understand the concept of cellular communication, frequency reuse, Cell capacity and coverage , handoffs strategies
4. Comprehend GSM standard, its architecture, logical channels, Data transmission in GSM and multiple access techniques in use.
5. Understand the evolution of mobile technologies
6. Summarize the principles and applications of networking standards.

Unit I - Traffic Engineering and Signaling
Telecommunication Traffic: Unit of Traffic, Traffic measurement, A mathematical model, Lost- call systems: Theory, traffic performance, loss systems in tandem, traffic tables. Queuing systems: Erlang Distribution, probability of delay
Signaling: CCITT signaling system and Digital customer line signaling.

Unit II - Mobile Radio Propagation:
Propagation Mechanism: Free space propagation model, Free space and two ray propagation model, Basic propagation mechanism. Indoor and outdoor Hata propagation model.
Small Scale Fading and Multipath: Types of Small scale fading, Small scale multipath propagation, Impulse response model of multipath channel and Small scale multipath measurements.

Unit III - Cellular Concept
Introduction to cellular telephone system, Cellular concept: Expansion of mobile system capacity through frequency reuse, Cell geometry, Selection of cluster size, Cell splitting and sectoring, Coverage and capacity in cellular system and Handoff strategies.

Unit IV - GSM Fundamentals
Introduction, Architecture of GSM, characteristics of GSM standards, services, Radio transmission parameters in GSM System, Applications, Description of call setup procedure, Handover mechanism in GSM, Security in GSM **GSM Channels and Services**

Traffic and Logical Channels in GSM, GSM time hierarchy, GSM burst structure, Description of call setup procedure, Handover mechanism in GSM, Security in GSM.
Data transmission in GSM: Data Services, SMS, HSCSD, GPRS, EDGE.
Multiple Access Techniques- OFDMA .

Unit V- Evolution of Mobile Technologies
Overview of LTE: LTE basics, LTE frame structure, LTE Design parameters with Standardization and Architecture of LTE.
5G Networking: Coordinated multi-point transmission(CoMP) in 5G: Joint Transmission enablers - Distributed cooperative transmission - JT CoMP with advanced receivers, Machine-type communications: Fundamental techniques for MTC - Massive MTC - Ultra-reliable low-latency MTC - Device-to-device (D2D) communications - Multi-hop D2D communications - Multi-operator D2D communication

Unit VI : Networking
Mobile Network Layer: MobileIP, DHCP, AdHoc, introduction to Routing protocols MANET vs VANET
Mobile Transport and Application Layer: Mobile TCP,WAP architecture, WDP

Text Books:
1. Theodore Rappaport, "Wireless Communications Principles and Practice", Second Edition, Pearson Education.
2. J. E. Flood , "Telecommunications Switching, Traffic and Networks", Pearson Education

Reference Books:
1. Fei Hu, "Opportunities in 5G Networks: A research& development perspective", CRC Press
2. Krzysztof Wesolowski, "Mobile Communication Systems", Wiley Student Edition
3. John C. Bellamy, "Digital Telephony", Third Edition; Wiley Publications
4. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press
5. Thiagarajan Vishwanathan, "Telecommunication Switching Systems and Networks"; HI Publications
6. AdityaJagannatham, "Principles of Modern Wireless Communication Systems"

List of Experiments:
1. Write a program to elaborate Lost call system/ delay system used in the analysis of voice/data traffic
2. Write a program to measure bit error rate in presence of AWGN model.
3. Write a program to simulate speech coding and decoding technique used in mobile Communication.
4. Write a program to simulate experiment on GMSK modulation.
5. Write a program to measure bit error rate in presence of Hata/ Multipath propagation model.
6. Study of VoIP call routing process
7. Perform an experiment / Simulate the operation of Multiple access techniques such as TDMA/ CDMA/ OFDMA.

ETUA40174A: Deep Learning (Elective-III)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: : Readers/students are expected to know the following concepts:
Machine Learning
Basics of Statistics and Probability
Linear Algebra

Course Objectives:

- To equip students with the basic understanding of the fundamental concept unsupervised learning.
- To understand concept of Autoencoder, its variants and usefulness in dimensionality reduction and data compression.
- To develop understanding of Reinforcement learning and apply in applications like recommender systems and gaming theories.
- To analyze the YOLO algorithms and apply it for object recognition.

Course Outcomes: On completion of the course, students will be able to

1. Develop the Convolutional neural networks and YOLO based object and face recognition applications.
2. Illustrate the unsupervised learning paradigms.
3. Analyze and compare different types of Autoencoders and apply them in dimensionality reduction.
4. Analyze the functioning of Variational Autoencoders and apply to generate latent spaces.
5. Design and evaluate the Generalized Adversarial Networks.
6. Demonstrate the reinforcement learning and apply its principles in recommender systems.

Unit- I: CNN and its applications

CNN visualization, Object classification using CNN, Object localization, Sliding window approach, Intersection of Unions , Anchor boxes, YOLO algorithm, non -maxima suppression, Face recognition, Fun with Neural style transfer

Unit –II : Unsupervised Learning

Supervised Vs Unsupervised, Dimensionality Reduction, Principal Components Analysis (Incremental PCA, Sparse PCA, Kernel PCA), Linear Discriminant Analysis, Independent Component Analysis, Clustering : k-Means Clustering ,Gaussian Mixture Model, Hierarchical Clustering, Application in Anomaly detection

Unit III : Autoencoders

Principle of Autoencoders, Auto encoder Vs PCA, Training Autoencoders , Sparse Autoencoder, Denoising Autoencoder, Contractive Autoencoder ,Convolution Autoencoder

Unit IV : Variational Autoencoders (VAE)

Principles of VAEs, Variational inference, Core equation, Optimization, Conditional VAE (CVAE),Stacked VAE,MNIST variational Autoencoder, Using CNNs for VAEs ,Applications of VAE's

Unit V : Generative Adversarial Networks (GAN)

Generative and discriminative models, Principles of GANs, Architecture structure basics, Deep

Convolution Generative Adversarial Network (DCGAN), Conditional GAN (CGAN), Types of GAN such as cycle GAN ,sim GAN and their applications

Unit VI: Reinforcement Learning

Principles of reinforcement learning (RL),The Q value,Q-Learning example, Nondeterministic environment, Temporal-difference learning, Deep Q-Network (DQN), Double Q-Learning (DDQN), Applications of RL

Text Books :

1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville, "Deep learning", MIT press, 2016.
2. Atienza, Rowel. Advanced Deep Learning with Keras: Apply deep learning techniques, autoencoders,
3. GANs, variational autoencoders, deep reinforcement learning, policy gradients, and more. Packt Publishing Ltd, 2018.
4. Michelucci, Umberto. Advanced applied deep learning: convolutional neural networks and object detection. Apress, 2019.

Reference Books:

1. Christopher Bishop, "*Pattern Recognition and Machine Learning*", Springer, 2007.
2. Josh Kalin ," *Generative Adversarial Networks Cookbook* " Packt Publishing Birmingham,2018

List of Experiments

All programs are expected to be written in Python using tensorflow, keras and other relevant libraries.

1. Develop a program using tensorflow and keras libraries to implement CNN based architecture which will detect the objects in the test images and provide its class and bounding box location as an output.
2. Write a program to implement the k means algorithms and use it in fraud /anomaly detection application.
3. Develop and test Autoencoder for MNIST data.
4. Write a program to compute the principal components of images and use it to compress an image. Evaluate the compression performance.
5. Implement and test Variational Autoencoder /Convolutional VAE over MNIST dataset. Compare its performance over Autoencoder.
6. Develop the Generator and discriminator in Generative adversarial network and test over MNIST dataset.
7. Develop a cycle GAN for pixel to pixel translation based application.
8. Build and train RL model using keras functions and develop application based on it.

Mini Project

Design and coding of an application based on the topics studied in this course.

ETUA40174B: Robotic Systems (Elective – III)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hr./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Basics of Power Electronics
Basics of Control Systems
Basics of Embedded Systems
Basics of Operating Systems

Course Objectives:

- To understand different aspects of robotic systems and its workspace
- To improve the architectural and programming aspects of robotic automation to deliver efficient outcome.
- To aware the student of their understanding from prerequisite subject to invoked new ideas to find real world solutions through robotic automation systems.
- To analyze the system performance simultaneously optimizing same for improvements.

Course Outcomes: On completion of the course, students will be able to

1. apply the previously acquired knowledge to design robotic solution.
2. simplify the process by developing mathematical modeling for AGV/UWV application.
3. analyze and simulate the robotic system using advance EDA and simulation tools.
4. design a robot structure in tune with application.
5. evaluate the performance of overall modules.
6. incorporate Human-Robot social distancing for safety of working environment.

Unit- I : Introduction to Autonomous Robot Systems and Applications

Robots: Definition, Types of robot: Manual, Semi Auto, Fully Autonomous. Application Workspaces: Under water, ground, Arial, Static, Dynamic, uncertain, Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Vision applications. Robot Actuation Systems: Electric, Hydraulic and Pneumatic; Timing Belts and Bearings, Parameters for selection of actuators Robotics and Automation for Industry 4.0

Unit- I : Introduction to ROSPY programming and Simulation

What is Robot Operating System: Definition, Working with ROS and Python 2.7 stable version, Working with different ROS Module : rospy, code *reusability*. Unix-based platforms (Ubuntu) Stable Platform, ROS components, ROS concepts, Computation graph and naming conventions, programming and simulating your first robot.

Unit –III : Robot Localization with Environment Mapping ROS

Introduction to SLAM, Different types of SLAM Sensor classification, Characterizing sensor performance, Sensor selection criteria for SLAM (four different criteria), Range Sensors [Contact Type : Touch sensor, Non-contact Type: IR, LiDAR, Ultrasonic, Laser, Vision based], 3D camera, Workspace relative and absolute position sensors, Global Positioning System (GPS), Sensor Networks, RFID, Blue tooth beacons, Case Study : Indoor SLAM System, Outdoor SLAM System

Unit IV : Path Planning Algorithm (AI)

Static workspace PPA : A*, Visibility graph Cell decomposition, Probabilistic Roadmaps methods, Rapidly-exploring random tree D*, JPS, Dynamic PPA, Path Optimization : GA,

Unit V : Mobile Robot Navigation

Open loop- closed loop, and different types of drives, PID controllers, Path retention, Linear and Non-linear controls, Case Study : Unmanned under water vehicles, Unmanned ground vehicles and Unmanned aerial vehicles Applications

Unit VI : Robot Safety and Social Robotics

Safe navigation, subordinate safety, human aware environment, collision avoidance in multi agent system, Human-Robot Interaction basics. Implicit vs explicit interaction.

Text Books :

1. Introduction to Autonomous Mobile Robots, Second Edition, By Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, ISBN: 9780262015356472
2. Mobile Robotics, A Practical Introduction, Authors: Nehmzow, Ulrich, Springer publisher, ISBN 978-1-4471-0025-6
3. Adaptive Navigation and Motion Planning for Autonomous Mobile Robots: Mobile Robots, Navigation, Path Planning, Visual Tracking and Sensor Integration, Ashraf Aboshosha, ISBN-13: 978-3846530207, LAMBERT publication
4. Path Planning for Autonomous Vehicle, Umar Zakir Abdul Hamid, DOI: 10.5772/intechopen.77593, ISBN: 978-1-78923-992-8, IntechOpen publisher

Reference Books :

1. Mobile Robotics, 1st Edition, by Luc Jaulin, Hardcover ISBN: 9781785480485, Book ISBN: 9780081004814, ISTE Press – Elsevier press
2. Path Planning Algorithms for Mobile Robots , Zeeshan Malik Muhammad ,Eizad Amre, Khan Muhammad Umer, ISBN-13: 978-3659585081, Lambert publication
3. Robot Navigation from Nature, Milford, Michael John,, ISBN 978-3-540-77520-1, Springer Tracts in Advanced Robotics
4. Mobile Robot Navigation and Localization: Roadmap-based Path Planning and Visibility Sector-based Localization, Jinsuck Kim, ISBN-13: 978-3639088489, VDM Verlag

List of Experiments:

Tools Required: Python Language, Development system, operating system, Robot simulators**,**

1. Selection of real world scenario where humans find problem to perform task which can be solved by introducing autonomous robot system.
2. To design the autonomous robot structure. which can be utilized to accomplish above selected task?
3. Identifying different modules required to complete the task. Students are expected to use simulation software / actual hardware to run required automation modules.
4. Integrating the modules to execute complete task.
5. Introducing all required safety measures inside the robotic system.
6. Analysis and optimizing the complete system.
7. Documentation and Publishing the complete PBL work online.

ETUA40174C: POWER ELECTRONICS FOR ELECTRIC VEHICLES (Elective - III)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Basic Electrical Engineering & DC Machines
AC / DC Circuits, Generation process, Electrical Measurements
Power Electronics – DC-DC Converters, Drives basics, Quadrant operations
Measurement and Control - Panel metering, harnessing, Alarms on Dashboard
Mechatronics and Basics of Automotive

Course Objectives:

- To study the operation of battery driven Electric Vehicle (EV) and energy management
- To get Know-how & aptitude towards future trends in Hybrid EVs
- To distinguish between different configuration of EVs with merits and demerits.
- To explain the construction and working of various Electric drives.
- To select drive for EV applications and energy storage technology.

Course Outcomes: On completion of the course, students will be able to

1. Understand working of Electric Vehicles and recent trends in EV
2. Analyze and rank performance of drive for EV application
3. Compare different batteries and energy management systems for efficient / reliable EV operation
4. Apply design knowledge from Power electronics for drives-train design

Unit- I: History and development of on-road Electric Vehicles (EV)
Introduction and history of development, Different configurations of hybrid EVs with block diagram representation, Merits & demerits of different configurations in view of vehicle efficiency and energy storage system.

Unit- II: Batteries and Energy management
Basics of EV batteries, specifications, power density, Energy density, Charging &Discharging cycle and recommended methodologies for charging. Fuel Cell, Fuel Cell for APU Applications. Battery systems, battery management electronics.

Unit –III Electric drive-train system and Propulsion overview
Architectures of hybrid (HEV), plug-in hybrid (PHEV) and electric vehicles (EV) ,Vehicle dynamics, MATLAB/Simulink modeling System design considerations, Rating and sizing of electric drivetrain components, Series Hybrid Vehicle Propulsion System, Parallel Hybrid Vehicle Propulsion System.

Unit IV Analysis and Design of Electric Drivetrain Components
Working, Configuration, Performance Analysis and Control for Bidirectional DC-DC converters, Inverters and motor drives. DC four quadrant Drives, Regenerative Braking
Ignition systems and cranking, comparison with petrol vehicles. Charging systems, charging stations.

Unit V: BLDC and Induction Motor Drives for Electric Vehicles
Types, Ratings, Construction, working and performance commutation, parameters of BLDC Motor.
Torque–Speed Characteristics, Sensorless BLDC Motor Control, Harmonics reduction.

Types, Ratings, Construction, working and performance parameters of AC Induction Motors.

Unit VI: Energy Management Systems

Introduction and classification of energy management strategies, Charging stations- overview, Implementation issues of energy management strategies.

Case Study : Electrical Vehicles and its impact – On energy sector / automobile / economy

Text Books :

1. Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India,
2. Ali Emadi, Handbook of Automotive Power Electronics and Drives, Taylor & Francis
3. Chris MI, M. Abul and David Wenzhong Gao, Hybrid Electrical Vehicle Principles and Application with Practical Perspectives.

Reference Books :

1. Iqbal Husain, Electric and Hybrid Vehicles Design Fundamentals
2. Vedam Subramaniam, Electric Drives: Concepts and Applications, TMH
3. John M. Miller , Propulsion System for Hybrid Vehicle
4. Bimal K Bose, Modern Power Electronics and AC Drives, Pearson Education
5. Mehrdad Ehsani, Yimin Gao and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory and Design

List of Experiments:

Each student should perform minimum 8 software based experiments using Spice Simulation - Psim, MATLAB / Simulink, NI or any appropriate open source tool/software to verify the concepts.

For analysis of sub-systems in Electric Vehicles Simulations and few On-board experiments are to be carried out. Usage of open source software is encouraged.

1. Simulate Battery Management System for Li-Ion batteries
2. Compare using simulation of charge – discharge cycle of different batteries used in EVs.
3. MATLAB / Simulink model of Electric Vehicle DC power distribution system
4. MATLAB / Simulink modeling of Electric Vehicle Powertrain
5. Modeling Re-generative braking system for Electric Vehicle
6. BLDC motor drive for Electric Vehicles – Simulation and demonstration of drive.
7. Compare torque-speed characteristics of BLDC and Induction motors using simulation
8. Time-based dynamic simulations of steering, ride, and handling using matlab / Simulink.
9. Performance analysis of Induction Motor drive for Electric Vehicle.
10. Study of Charging Station for Electric Vehicles.

ETUA40174D: Speech and Audio Processing (Elective – III)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Signals and Systems
Basics of Digital Signal Processing

Course Objectives:

- To equip students with the basic understanding of the fundamental concept speech production and speech perception
- To understand the theoretical framework of speech signal processing and implementation of speech processing algorithms
- To understand practical implementation of speech processing application framework.

Course Outcomes: On completion of the course, students will be able to

1. Interpret speech production process and classify speech signal (such as voiced vs unvoiced; vowels vs consonants)
2. Explain speech perception mechanism and its relevance in speech processing.
3. Use the basic concepts of signal processing for computation of speech parameter such as Energy, autocorrelation, spectrogram etc.
4. Use the concept speech production and perception for computation and practical implementation of speech features such as LPC, MFCC.
5. Use the speech production and processing concepts for the practical implementation of speech coding algorithms such as LPC, channel vocoder, cepstral vocoder.
6. Explain speech processing concepts and apply them to build speech processing applications such as ASR, speech enhancement, speaker recognition

Unit- I: Fundamentals of speech production

Anatomy and physiology of speech production, Human speech production mechanism, LTI model for speech production, Nature of speech signal, linear time varying model, articulators, articulatory phonetics, manner of articulation, place of articulation, acoustic phonetics, spectrogram, classification of speech sounds: vowels, semivowels, nasal diphthongs, stops, affricates, fricative, vowel triangle.

Unit II: Human auditory system and speech perception

Anatomy and physiology of the ear, outer ear, middle ear and inner ear. Human auditory system, simplified model of cochlea. Sound perception, Auditory psychophysics, thresholds, just noticeable differences (JNDs), Sound pressure level and loudness. Sound intensity and Decibel sound levels. Pitch perception, masking, Concept of critical band and introduction to auditory system as a filter bank, Uniform, non-uniform filter bank, mel scale and bark scale. Speech perception: vowel perception. Coarticulation effects. Consonant perception, perception of manner of articulation feature. Perception of place of articulation.

Unit III: Time and frequency domain methods for speech and audio signal analysis

Time-dependent speech processing. Short-time energy, short time average magnitude, Short time average zero crossing rate. Speech Vs. silence discrimination using energy and zero crossing rate. Short-time autocorrelation function, short-time average magnitude difference function. Pitch period estimation using

autocorrelation method. Audio feature extraction, Spectral centroid, spectral spread, spectral entropy, spectral flux, spectral roll-off. Spectrogram: narrow band and wide band spectrogram

Unit IV: Linear prediction and cepstral analysis

Basic principles of linear predictive analysis. Autocorrelation method, covariance method. Solution of LPC equations: Durbin's recursive solution, lattice formulations and solutions. Frequency domain interpretation of LP analysis. Applications of LPC parameters as pitch detection and formant analysis
Homomorphic processing of speech signal, application of cepstral analysis for vocal tract vocal cord parameter estimation (formants and Pitch). Computation of MFCC.

Unit V: Speech and Audio coding

Time domain waveform coding: linear PCM, companded PCM, DPCM, DM, ADM. Spectral coders: Filter bank analysis, sub-band coders, Adaptive transform coders (ATC), Harmonic coding. Linear predictive coders (LPC), Non-LP source voice coders: phase vocoders, channel vocoders, excitation for vocoders, Homomorphic (Cepstral) vocoders. Speech coding standards and applications.

Unit VI: Digital speech processing for man-machine communication

Automatic speech recognition (isolated word recognition, automatic telephone number dialing system etc. using statistical signal modelling e.g. GMM, GMM-HMM), Linear and dynamic time warping, text to speech synthesis, speaker recognition and verification, speech enhancement, Introduction to Musical instrument classification, Musical Information retrieval.

Text Books :

1. L. R. Rabiner and S.W. Schafer, ―Digital processing of speech signals. Pearson Publication.
2. Douglas O'Shaughnessy, ―Speech Communications: Human and Machine: 2nd Edition Universities Press.

Reference Books :

1. Thomas F. Quateri ―Discrete-Time Speech Signal Processing: Principles and Practice. Pearson Publication.
2. Shaila Apte, Speech and audio processing, Wiley India Publication
3. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, Wiley India.
4. L. R. Rabiner, B. H. Juang and B. Yegnanarayana, Fundamentals of speech recognition. Pearson Publication

List of Experiments:

Each student should perform minimum 8 software based experiments using Matlab, Python or any appropriate open source tool/software to verify the concepts. For analysis of speech signals tools like PRAAT, Audacity can be used. Open source software is encouraged.

1. Record speech signal (isolated words, continuous speech) and analyze the speech signal using speech analysis tool (e.g. PRAAT). Observe spectrogram, pitch, formants, intensity etc.
2. Write a program to compute short time Energy and ZCR for different frame rates and comment on the result.
3. Write a program to classify voiced, unvoiced and silence frames using frame level energy and zero crossing rate
4. Write a program to compute narrow band and wide band spectrogram. Comment on the time and frequency resolution of wide band and narrow band spectrogram.
5. Write a program for extracting pitch period for a voiced part of the speech signal using autocorrelation method and average magnitude difference function (AMDF).
6. Write a program to design a Mel filter bank and using this filter bank write a program to extract MFCC features.

7. Write a program to perform the cepstral analysis of speech signal and detect the pitch from the voiced part using cepstrum analysis.
8. Write a program to find LPC coefficients using Levinson Durbin algorithm.
9. Write a program to enhance the noisy speech signal using spectral subtraction method.
10. Write a program to extract frequency domain audio features like SC, SF and Spectral roll off.

ETUA40174D: Business Intelligence (Elective – III)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Database Management System

Course Objectives:

- To study and understand the importance of Business Intelligence and need of data preparation for Business Intelligence.
- To study and understand the different components of analytics landscape and project cycle aligned with these components.
- To study and understand different data transformations, data modelling steps and visualize the data on the data models.
- To study and understand the ways of adding custom calculations needed and understanding the applications of different statistical concepts.
- To study and understand the BI deployments, administration cycle of BI implementations using Power BI
- To study and understand various topics and concepts in the areas of analytics and their industrial applications through study of different use cases.

Course Outcomes: On completion of the course, students will be able to

1. Describe the importance of Business Intelligence and need of data preparation for Business Intelligence.
2. Identify, describe, relate to the concepts of different components of analytics landscape and project cycle aligned with these components.
3. Design and develop different data transformations, data models, analyse and visualize the data.
4. Design and develop custom calculations based on business and technical needs and demonstrate and implement different statistical concepts.
5. Author BI deployments, BI environments.
6. Describe and compare industrial BI implementations, use cases and current and future trends.

Unit I: Need of Analytics and Data Preparation

Introduction to Analytics: What is Analytics? Need of Analytics, Why Microsoft Power BI?, Types of Business Analytics

Data Sources: Data Collection, Transactions Entry, Organizational Systems, Data Sources and Data Source Categories, Issues in Data and Need of Data Preparation

Need of Data Preparations: What is Data Preparation? Joining data, Appending Data, New Calculations, Removing Inconsistencies, Transposing

Setting up Power BI: Installation and configuration of Power BI Desktop, Setup of required connector

Unit II: Data Landscape and Project Cycle

Understanding Data and Databases: What is a database? What is a DBMS?, What is SQL?, What are tables?, Organization of tables in databases, Types of Data, Database Keys, Relationships between tables, Joins and Unions, Cross-database Joins, Type of Data: Structured, Unstructured and Semi-structured data

Data Architecture: BI Architecture, Data Security and Governance, Administration

Analytics Project Lifecycle: Requirements Understanding, Data Understanding, Wireframes, Data Preparation, Data Visualization, Deployment, Documenting, Project Team and Roles, Challenges in Projects

Unit III: Data Modelling and Visualization

Data Integration and Data Warehouses: What is Data Integration? Need of Data Integration, ETL, What is Data Warehouse? Need of Data Warehouse, Facts and Dimensions, Star Schema and Snowflake Schema, Data Marts

Data Transformation [Basics]: Merging and Appending Data, Filtering, Cleaning Data, Fixing Errors, Transforming Data, Aggregating Data

Data Modelling: Setting Relationships, Creating Data Models

Data Visualization: What are KPIs?, Dashboards, Reports and Scorecards, Types of Dashboards, Slicers and Filters, Setting interactivity, Creating Hierarchies, Groups, Drilldowns and Drill-through, Formatting your visualizations, Best practices of visualizations, Aggregations: SUM, MAX, AVG, MIN

Unit IV: Custom Calculations and Analytics

Data Transformations [Advanced]: Tabular Model at database level, Cross-database joins

Calculations: Calculated Fields, Calculated Measures, Time-intelligent Functions, Moving Averages and Running Total, What-if Analysis, Conditional formatting

Statistical Analytics: Mean, Mode, Median, Variance and Standard Deviation, Simple Regression, Multiple Regression

Unit V: Power BI Deployment, Administration and Mobility

Power BI Deployment: Overview of Power BI Service, Publishing to Power BI Service. Understanding the Power BI Service Workspaces, Apps, Creating Dashboards in Power BI Service, Subscriptions, Comments and Data Driven Alerts, Authoring reports within Power BI Service, sharing dashboards across your organization, Configuring Gateways, scheduling automated refresh of your reports using Data Gateway

Power BI Advanced Features: Using NLP to creating dashboards, Influencers, Delivering Insights, Explain Analysis

Mobile Analytics: Creating Dashboards for Mobiles, Using dashboards and reports using Mobile App

Unit VI: Industry Analytics Landscape

Working with Tableau: Introduction to Tableau, Installation and Setup of Tableau Desktop, Visualizing with Tableau

Advanced Concepts: Web Analytics, Sentiment Analysis, Big Data, Data Lakes, IoT

Applications of Business Analytics: Manufacturing Use Cases, EPC Use Cases, Retail Use Cases, Future Trends of Analytics

Text Books:

1. "Business Intelligence Guidebook: From Data Integration to Analytics" by Rick Sherman, Elsevier Inc.
2. "Successful Business Intelligence, Second Edition: Unlock The Value of BI & Big Data" by Cindi Howson, McGraw Hill Edition
3. "Data Analytics for Beginners: Your Ultimate Guide to Learn And Master Data Analysis. Get Your Business Intelligence Right – Accelerate Growth and Close More Sales" by Victor Finch
4. Data Strategy: How To Profit From A World Of Big Data, Analytics And The Internet Of Things" by Bernard Marr, Koganpage Publicaitons, Auva Press

Reference Books:

1. "Performance Dashboards – Measuring, Monitoring, And Managing Your Business" by Wayne Eckerson, John Wiley & Sons, Inc.
2. "Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications" by Larissa T. Moss & Shaku Atre, Addison-Wesley information Technology Series
3. "Artificial Intelligence: Building Intelligent Systems" by Dr. Parag Kulkarni, Dr. Prachi Joshi, PHI publication (for understanding of concepts)

List of Assignments:

1. Creating multiple sample tables and joining them in Power BI
2. Connecting to data source and transforming data in Power BI
3. Connecting to data source and creating data models by establishing relationships
4. Connecting to data source and visualizing and analysing data
5. Connecting to data source and creating custom calculations
6. Deploying the dashboards and reports to Power BI Service
7. Administering and using advanced features of Power BI Service
8. Creating Mobile layouts in Power BI Desktop

ETUA40175: Intellectual Property Rights

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): - Practical (P): -	-	-	50	-	-	-	50

Course Objectives:

- Explain the importance of ideas, concept and creativity
- Transfer the knowledge about the IPR required for Engineer's
- Describe how IPR creates National wealth
- Teach National and International IP System

Course Outcomes: On completion of the course, students will be able to

1. Infer that tomorrow's world will be ruled by ideas, concept, and creativity
2. Summarizing about Intellectual Property Rights which are important for students of engineering as they are tomorrow's technocrats and creator of new technology.
3. Discover how IPR are regarded as a source of national wealth and mark of an economic leadership in context of global market scenario.
4. Analyze national & International IP system.

Unit I:

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives of understanding Intellectual Property Rights ,IPR and IITs

Unit II:

Understanding the types of Intellectual Property Rights: - Patents, Designs, Trademarks (Registered and unregistered trademarks), Copyright, Traditional Knowledge, Geographical Indications, Trade Secrets, Idea Patenting, (Case Studies)

Unit III:

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Indian Patent Office and its Administration .

Unit IV:

Administration of Patent System – Patenting under Indian Patent Act, Patenting under PCT, Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non Provisional Patent Application and Specification

Text Books:

1. Resisting Intellectual Property by Halbert, Taylor& Francis Ltd ,2007.
2. Industrial Design by Mayall, Mc Graw Hill.
3. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

Reference Books:

1. Intellectual Property Rights under WTO by T. Ramappa, S. Chand
2. Introduction to Design by Asimov, Prentice Hall

Module – III

ETUA42171A: Image and Video Processing (Elective – IV)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Basic Programming skills, Signal Processing fundamentals, Basic linear algebra, Basic python

Course Objectives:

- To learn the fundamental concepts of image and video processing
- To design and implement algorithms for image enhancement, smoothing and sharpening of images
- To make the students understand the techniques used in image segmentation, morphological image processing and use them for feature extraction
- To understand and compare different techniques for image compression and image restoration
- To equip students to apply the image processing techniques in real life applications

Course Outcomes: On completion of the course, students will be able to

1. Understand the steps in digital image processing and perform basic operations on gray and color images
2. Apply spatial domain and frequency domain filters for image enhancement, smoothing and sharpening
3. Perform image segmentation and morphological image processing
4. Apply image processing techniques for extraction of features in the image
5. Compare different techniques for image compression and image restoration
6. Understand the steps in video processing and perform basic operations

Unit- I : Fundamentals of Image Processing

Introduction to Image Processing? Examples of Fields that Use Image Processing, Fundamental Steps in Image Processing, Human visual system, Image acquisition, Sampling & quantization, representing digital images, Spatial & gray-level resolution, Image file formats, Basic relationships between pixels, Distance Measures, Statistical properties of images-histogram, mean, variance, MSE, PSNR.
Color Image fundamentals & color models – RGB, CMY,HSI ,YIQ.

Unit –II : Image Processing in spatial and frequency domain

Basic Mathematical Tools Used in Digital Image Processing, Elementwise versus Matrix Operations, Linear versus Nonlinear Operations, Arithmetic Operations, Intensity Transformations and Spatial Filtering: Basic Intensity Transformation, Histogram Processing, Fundamentals of Spatial Filtering: 2D convolution, smoothing and sharpening filters
Filtering in the Frequency Domain: 2D DFT, Smoothing and Sharpening in frequency domain.

Unit III : Image Segmentation and Morphological Image Processing

Image Segmentation: Point, Line, and Edge Detection-Gradient Operators, Advanced Techniques for Edge Detection -Marr-Hildreth Edge Detector, Canny Edge Detector, Edge linking- Hough Transform, Thresholding –Otsu's Method, Variable Thresholding Based on Moving Averages, Segmentation by Region Growing and by Region Splitting and Merging, Segmentation Using Clustering and Superpixels , Active Contours: Snakes and Level Sets, Segmentation Using Graph Cuts, Morphological Operations: Dilation, Erosion, Opening, Closing, Boarder extraction, Hole/region filling, Extraction of Connected Components, Cleaning the border

Unit IV : Feature Extraction

Boundary Preprocessing, Boundary Feature Descriptors, Region Feature Descriptors, Principal Components as Feature Descriptors, Harris-Stephens Corner Detector, Scale-Invariant Feature Transform (SIFT) features, SURF features, Pattern Classification: Minimum-Distance Classifier, Deep Convolutional Neural Networks for feature extraction

Unit V : Image Compression and Image restoration

Types of redundancy, Bit-plane coding, lossless versus Lossy compression, Introduction to DCT, Wavelet transforms, Lossy compression – DCT based compression, Introduction to JPEG & JPEG2000, Digital Image Watermarking

Image Degradation/Restoration Process, Noise models and Restoration of images degraded due to noise, Inverse and Wiener Filtering

Unit VI : Fundamentals of video Processing

Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Motion Estimation; Video Filtering; Video Compression, Video coding standards MPEG, Concept of sparsity in image and video processing ,Case studies of Image and video processing

Text Books :

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Fourth Edition, - Pearson Education
2. Iain E. G. Richardson, ―H.264 and MPEG Video Compression: Video Coding for Next-generation Multimedia. Wiley

Reference Books :

1. Sonka ,et al. Image processing, analysis and machine vision
2. Alan C. Bovik, Handbook of Image and video processing, Academic press, 2010
3. AK. Jain, Fundamentals of digital image processing, Prentice Hall of India
4. M.A. Joshi et al, Image and Video Compression: Fundamentals, Techniques & Applications, CRC press

List of experiments (Any 8): Open source libraries may be used for the experiments

1. Introduction to MATLAB IP toolbox, Scikit Image processing package skimage, PIL-Python Image Library and OpenCV for Image processing
2. To perform Basic operations on image Processing, Affine transformation- rotation, scaling, Histogram processing, color image processing- conversion of image from one color space to other, pseudo coloring
3. To perform Image Filtering in spatial domain: 2D convolution and spatial filtering, Image processing in frequency domain
4. To perform Image Filtering in frequency domain
5. To perform Image Restoration- Noise removal, Image deburring
6. To perform Morphological operations for Feature extraction
7. To perform Image segmentation
8. To perform Basic operations related to video processing – motion estimation, object detection
9. To implement JPEG image compression scheme
10. Real life application- Face detection and recognition/ object detection and classification/ vision based measurement and quality inspection/ any other

ETUA42171B: High Performance Computing (Elective – IV)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2hrs./week-	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Processor architecture in general, any one programming language with modularization

Course Objectives:

- To create awareness for parallel processing methods and architectures.
- To be familiar with design issues in parallel processing algorithms.
- To make the students familiar with Nvidia parallel architecture model for programming.
- To make the students familiar with Nvidia CUDA programming with examples.
- To equip students with open source methodology for parallel programming other than Nvidia architecture.
- To make students familiar current trends in parallel programming.

Course Outcomes: On completion of the course, students will be able to

1. Understand the parallel processing methods and architectures
2. Understand design issues in parallel processing
3. Understand the Nvidia parallel architecture model for programming
4. Design and deploy CUDA programming technique for applications
5. Understand and apply open source methodology for parallel programming other than Nvidia architecture
6. Understand state of the art in parallel programming methods

Unit- I: Basics of Parallel Processing

Levels of parallelism (instruction, transaction, task, thread, memory, function)
Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc.)
Architectures: N-wide superscalar architectures, multi-core, multi-threaded

Unit –II: Design issues in Parallel Processing

Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms

Unit –III: CUDA based Parallel Programming-I

Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU), Memory hierarchy and transaction specific memory design, Thread Organization

Unit –IV: CUDA based Parallel Programming-II

Vector Addition, Matrix Multiplication algorithms. 1D, 2D, and 3D Stencil Operations. Image Processing algorithms – Image Blur, Gray scaling. Histogramming, Convolution, Scan, Reduction techniques.

Unit V: Parallel Programming with shared memory and MPI:

Symmetric and Distributed architectures, OpenMP Introduction. Thread creation, Parallel regions. Work-sharing, Synchronization. MPI Introduction. Collective communication. Data grouping for communication.

Unit VI: Trends in parallel Computing

Petascale Computing, Optics in Parallel Computing, Quantum Computers, trends in processor technology and its impact on HPC

Text Books:

1. "Highly Parallel Computing", by George S. Almasi and Alan Gottlieb
2. "Advanced Computer Architecture: Parallelism, Scalability, Programmability", by Kai Hwang, McGraw Hill 1993
3. Wen-Mei W Hwu, David B Kirk, Programming Massively Parallel Processors A Hands-on Approach, Morgann Kaufmann, 3e.

Reference Books:

1. "Scalable Parallel Computing", by Kai Hwang, McGraw Hill 1998
2. "Principles and Practices on Interconnection Networks", by William James Dally and Brian Towles, Morgan Kauffman 2004.
3. GPU Gems 3 --- by Hubert Nguyen
4. Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, © 2007.

List of experiments:

1. Introduction to CUDA tools for parallel processing.
2. GPU programming for vector addition and matrix multiplication with CUDA framework
3. GPU programming for picture scaling and Histogramming with CUDA framework
4. Open MP based programming for vector addition and matrix multiplication.
5. Open MP based programming for depicting producer consumer problem.
6. MPI based programming for vector addition and matrix multiplication.
7. MPI based programming for depicting producer consumer problem.
8. Design and implement real time application with any method of parallel computing.

ETUA42171C: Wireless Networks (Elective – IV)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know the following concepts:
Basics of Computer network.
Basics of Mobile Communication.

Course Objectives:

- To study the evolving wireless technologies and standards
- To understand the architectures of various access technologies such as 3G, 4G, 5G and WiFi etc.
- To understand various protocols and services provided by next generation networks.

Course Outcomes: On completion of the course, students will be able to

1. Apply concepts of the transmission of voice and data through various networks
2. Apply wireless trends in communication field.
3. Apply latest wireless technologies.
4. Analyze different WiFi services in different generations.
5. Apply different Mobile services in different generations.
6. Apply knowledge of network security protocols and their counter measures.

Unit I : Introduction to Wireless Networks

Introduction, Technology and service trends of Emerging Wireless technologies, The Amazing Growth of Mobile Communications, A Little History, Mobile Communications Fundamentals, Mobile Data, WiFi, Bluetooth, Cable Systems, Wireless Migration Options, Harmonization Process.

Unit II: WiFi and Next Generation WLAN

WiFi (802.11), Family of Wireless LAN Standards and Details (IEEE 802.11; a,b,g,n,ac,ad,af,ad,ax and introduction to 802.11be), WiFi Protocols, Frequency Allocation, Modulation and Coding Schemes, Network Architecture, Typical WiFi Configurations, Security, 802.11 Services, Hot Spots, Virtual Private Networks (VPNs), Mobile VPN, VPN Types, WiFi Integration with3G/4G, Benefits of Convergence of WiFi and Wireless Mobile.

Unit III: Third Generation Mobile Services

Introduction, Universal Mobile Telecommunications Service (UMTS), UMTS Services, TheUMTS Air Interface, Overview of the 3GPP Release 1999 Network Architecture, Overview ofthe 3GPP Release 4 Network Architecture, Overview of the 3GPP Release 5, All-IP NetworkArchitecture, Overview CDMA2000, TD-CDMA, TD-SCDMA, Commonality among WCDMA,CDMA2000, TD-CDMA, and TD-SCDMA

Unit IV : LTE

LTE Ecosystem, Standards, Radio Spectrum, LTE Architecture, User Equipment (UE),Enhanced Node B (eNodeB), Core Network (EPC), Radio Channel Components, TD-LTE, Multiple Input Multiple Output, LTE Scheduler, Carrier Aggregation, Cell Search, Cell Reselection, Attach and Default Bearer Activation, Handover (X2, S1, Inter-MME), Self-Organizing Networks (SONs), Relay Cells, Heterogeneous Network (Het NET), Remote Radio Heads (RRH), VoLTE, LTE Advanced

Unit V : Introduction to 5G Network

Introduction, Requirement of 5G, 5G overview of standardization and regulation, ITU-R activities from 3G to 5G, 5G and IMT-2020, 3GPP standardization,5G NR new Radio and its frequency bands

Unit VI : Wireless Network Security

Introduction, How Wi-Fi works, WEP, Technique of hacking wireless network, countermeasure

Text Books :

1. Clint Smith, P.E., Daniel Collins, "Wireless Networks: Design and Integration for LTE,EVDO, HSPA, and WiMAX", McGrawHill Education, Third Edition
2. EldadPerahia, Robert Stacey, "Next Generation Wireless LANs", Cambridge University Press, Second Edition.
3. William Stallings, "Network Security Essentials Applications and Standards", 5th Edition, Pearson publication

Reference Books :

1. Yi-Bang Lin, ImrichChlamtac, "Wireless and Mobile Network Architecture", Wiley India Edition.
2. DipankarRaychaudhary, Maria Gerla, "Emerging Wireless Technologies and the Future Mobile Internet", Cambridge University Press.
3. Erik Dahlman Stefan Parkvall Johan Skold, "5G NR: The Next Generation Wireless Access Technology" 1st Edition, Elsevier Publication

List of Experiments: Perform Any 8 Experiments

1. Study of different wireless network components and features (Details of any one feature used for Mobile Security Apps).
2. Study the hidden node problem in WLAN (NetSim).
3. To create scenario and study the performance of CSMA / CD protocol through simulation.
4. Establish Wi-FI to bus (CSMA) connection (NS2/Lab-view/Matlab).
5. To Study Frequency Hopping Spread Spectrum (FHSS) Modulation and Demodulation Technique
6. Establish Wi-FI connection to LTE (4G) (NS2/Lab-view/Matlab).
7. To implement Data encryption and decryption (NS2).
8. Study and analyze the Buzzer/ Power Management Unit in 4G LTE Smart Phone.
9. Study and understand the Basic circuit of 4G LTE Mobile phone (Transmitter, Receiver and Base band control Section).
10. Study and analyze and compare the in 3G, 4G and 5G Smart Phone system.

IOEUA42172A: Introduction to Gaming (Open Elective – I)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2hrs./week Tutorial (T): - Practical (P): 2hrs./week	20	30	20	30	-	25	125

Prerequisite:

Course Objectives:

- To learn about the video game art principles, Video Game production, Design Process and the Industry
- To understand and distinguish Video game elements, genres, types ad hardware
- To Study various video game production practices, terminology, Industry roles and responsibilities
- To know the application and use of a game engine across various verticals and develop and learn how to work with the game engine as a tool for production
- To examine and game engine interface, coding, game objects, asset Store, services, etc

Course Outcomes: On completion of the course, student will be able to

1. Use terminology related to Games and Interactive Media Industry
2. Relate to Industry demands and structure project as per required specifications
3. Define Specifications for the execution of the project
4. Demonstrate game engine tools usage across art, animation, asset management, Interface, Audio, Lighting, Materials, Physics and Programming systems.
5. List and select gaming services related to project structure
6. Develop basic interactive games

Unit- I : Introduction to Games Industry

Video game production techniques, hardware, production roles and responsibilities, Video game design elements, game genres, game types, examples of gaming platforms, gaming services, video game controls, video game industry terms, model asset optimization, asset store, video game art principles, video game industry practices, video game industry terminology

Unit-II : Game Engine Fundamentals

Gaming engine user interface, hierarchy, editor, game Window, navigation, inspector, scene, project, game object, prefab, models, tags, sounds, assets, project management, materials, textures, effects, lights, modelling practices and optimization practices, Import system, managing materials, managing textures

Unit III: World Building and Animation

Environment, Static Meshes, Rigid Body, Colliders, Preparing for lighting, Light tools, light types, User Interface, Art principles, Sprite editor, Lighting process, Baking process, Animated objects, Importing animation, Setting up animation states, Animation controllers, Transition, Animation refinement

Unit IV: Scripting a Game Development

Script types, Variables, Methods, C# fundamentals, Game mechanics, Ray casting, Program Debugging, Various Error states, Navigation, Nav Mesh, Building NPC, Simple AI, Enemy System, Particle system, Adding Game audio, Audio types, Audio formats, Audio clips and properties, Camera System, Building camera system, Player Behaviors, User Interface system, User Interface Implementation, Properties of UI, Build tools, Cloud Services, Console, Build Settings, Platforms, Publishing tools, Mobile Publishing

Text Books :

1. Tom Meigs, Ultimate Game Design: Building Game Worlds 1st Edition, McGraw-Hill Education, 2003
2. Sam R. Kennedy, How to Become a Video Game Artist: The Insider's Guide to Landing a Job in the Gaming World, Watson-Guptill, 2013

Reference Books :

1. Penny de Byl, Holistic Game Development with Unity: An All-in-One Guide to Implementing Game Mechanics, Art, Design and Programming, 2nd Edition, A K Peters/CRC Press, 2017
2. Mike Geig, Unity 2018 Game Development in 24 Hours, Sams Teach Yourself, 3rd Edition, Sams Publishing, 2018

List of Experiments:

Develop a game "Roller Madness" in Unity environment as following assignments

1. Implement the Setting Up the Scene, Camera Setup
2. Implement the Physics system
3. Configure the Player Control and Appearance
4. Health and Damage, Pickups,
5. UI Basics and Game Manager,
6. Create the Enemies
7. Implement the Particle System
8. Implement Animations to the game avatar
9. Spawners to create multiple objects of same type

Note :Perform any 6 experiments based on syllabus

IOEUA42172B: Inferential Statistics for Data Science (Open Elective – I)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2hrs./week Tutorial (T): - Practical (P): 2hrs./week	20	30	20	30	-	25	125

Prerequisite: Readers/students are expected to know the following concepts:
Basics of Probability

Course Objectives:

- To equip students with the basic understanding of the fundamental concept of data and the nature of data sets
- To understand the fundamentals of probability distributions and their application for data analysis
- To derive the conclusions from the data sets with Bayesian and Inferential statistics

Course Outcomes: On completion of the course, students will be able to

1. Comprehend and correlate the nature and central tendency of given data sets using appropriate probability distribution for the given data set.
2. Implement the fundamentals of Bayesian statistics to find out probability of unknown parameters of statistical model
3. Analyze and conclude the hypothesis using inferential statistical tests
4. Evaluate the prominent characteristics of data sets with exploratory data analysis methods

Unit- I : Understanding Data and probability distributions

Understanding Data, Frequency Tables, Distributional Shapes, Central Tendency
Describing Spread: Range, Interquartile Ranges and Standard Deviation , Measuring Data ,Measurements of Central Tendency, Measurements of Dispersion, Bi-variate Data and Covariance ,Pearson Correlation Coefficient, Uniform Distribution, Binomial Distribution, Poisson Distribution, Normal Distribution, Normal Distribution - Formulas and Z Scores

Unit-II : Bayesian Statistics

Likelihood function and maximum likelihood, The minimaxity, Computing the MLE, Computing the MLE: examples ,Continuous version of Bayes' theorem, Priors and prior predictive distributions
Prior predictive: binomial example, Posterior predictive distribution, Bernoulli/binomial likelihood with uniform prior, Conjugate priors

Unit III: Inferential analysis

Central limit theorem and Hypothesis Testing , t-tests, Sensitivity Analysis ,chi square test, Correlation-values and confidence intervals, Use Analysis of Variance (ANOVA) or Analysis of Covariance (ANCOVA),Regression analysis

Unit IV: Exploratory Data Analysis

Univar ate data: measures of center and spread, transformations, visualization. – Bivariate data: Simple regression, curve fitting, – Trivariate/Hypervariate data: Multiple regression, model selection, principal components. – Binary responses: Logistic regression, residuals. – Categorical data: Contingency tables, correspondence analysis. – Distance data: Multi-dimensional scaling, non-linear dimensionality reduction. – Graph data: Descriptive statistics, spectral methods, visualization.

Text Books :

1. Sahu**,** Pradip Kumar, **Pal**, Santi Ranjan, **Das**, Ajit Kumar, "Estimation and Inferential Statistics", Springer
2. S.C. Gupta and V. K. Kapoor : Fundamentals of Mathematical Statistics, Sultan Chand and Sons, , New Delhi.
3. Manoj Kumar Srivastava, Abdul Hamid Khan, Namrata Srivastava, "Statistical Inference, Theory of estimation", PHI

Reference Books :

1. George Casella, Roger Berger," Statistical Inference ",CENGAGE Learning, Second Edition
2. Malcom O, Asadoorian, Demetri Kantarelis, "Essentials of Inferential Statistics", University Press of America.

List of Experiments: Perform experiments using Python/R

1. Study of Hypothesis testing (One sample t test, z test)
2. Analysis of variance (ANOVA)
3. To study Linear regression to predict the outcome of a variable
4. Study of outlier in Predictive analysis
5. Finding the most important predictor variable in a dataset for feature Selection
6. Model selection and analysis for a real world dataset
7. Study of Logistic Regression
8. To build an application: Time series forecasting

IOEUA42172C: Solar and Wind Energy (Open Elective-I)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2hrs./week Tutorial (T): - Practical (P): 2hrs./week	20	30	20	30	-	25	125

Prerequisite: Readers/students are expected to know the following concepts:
Basic Mechanical Engineering,
Basic Electrical and Electronics Engineering

Course Objectives:

- To understand fundamentals of solar and wind energies.
- To understand constructions, working principle and design procedure of solar and wind power plants.
- To apply basic engineering principle to design a simple solar and wind power system.

Course Outcomes: On completion of the course, students will be able to

1. Understand solar radiation and geometry principles.
2. Apply aspects of solar thermal system and its practical applications.
3. To aware design process of solar food drier/solar cooker/solar pv system for domestic purpose.
4. Design miniature wind mill for domestic purpose referring existing system.

Unit I: Solar Energy Principles

Present solar energy scenario, world energy futures, governing bodies (self-study), solar radiations and its measurements, solar constant, solar radiation geometry, solar radiation data, estimation of average solar radiation, solar radiation on tilted surface.

Unit II: Solar Thermal Systems and Applications

Types of Solar thermal collector, flat plate collector analysis, Evacuated tube collectors (ETC) analysis, its design and application, solar air heaters and its types, solar distillation.
Solar Concentrating collectors: types- line and point concentrator, theory of Concentrating collectors, parabolic trough collector, parabolic dish collector, solar tower, concentrated Fresnel linear receiver (CFLR).

Unit III: Solar Photovoltaic and Applications

Forming the PN junction solar cells & its applications, Structure of a solar cell, types of modules, PV array, solar cell equation, Fill factor and maximum power, Grid aspects of solar power, equipment used in solar photovoltaic plants, Power Conditioning Equipment-inverters, Regulators, Other Devices; System Analysis-Design Procedure, Design Constraints, Other Considerations.

Unit IV: Wind Energy

Principle of wind energy conversion; Basic components of wind energy conversion systems; various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations, wind energy potential and installation in India.

Text Books:

1. G. D. Rai, 'Non-Conventional Energy Sources', Khanna Publisher
2. S. P. Sukhatme, 'Solar Energy: Principles of thermal collections and storage', McGraw Hill

3. Tiwari G N. 'Solar Energy: Fundamentals, design, modeling and Applications', Narosa, 2002

Reference Books :

1. Mukund R. Patel, 'Wind And Solar Power Systems: Design, Analysis and Operation, Second Edition', CRC Press
2. Kreith And Kreider, Solar Energy Handbook, McGraw Hill
3. Ray Hunter, 'Wind Energy Conversion: From Theory to Practice', John Wiley and Son Ltd
4. Gary L Johnson, 'Wind Energy Systems', Prentice-Hall Inc., New Jersey
5. Martin O L Hansen, 'Aerodynamics of Wind Turbines', James & James / Earthscan.
6. Goswami D Y, Kreith F, Kreider J F, 'Principles of Solar Engineering', Taylor & Francis
7. Robert Gasch, 'Wind Power Plant Fundamentals, Design, Construction and Operations', Springer
8. C S Solanki, 'Solar Photovoltaic: Fundamentals, Technology and Applications', PHI Learning

List of Experiments:

1. Design of solar food drier for domestic purpose referring existing system.
2. Design of parabolic dish solar cooker for domestic purpose.
3. Design and analysis of liquid flat plate type heater used in domestic purpose
4. Design of solar photovoltaic system for domestic/ commercial building purpose.
5. Case study on designing miniature wind mill for domestic purpose referring existing system.
6. Visit to solar PV system used in commercial building.
7. Visit to wind power system used in commercial building.

IOEUA42172D: Numerical Methods in Engineering (Open Elective - I)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2hrs./week Tutorial (T): - Practical (P): 2hrs./week	20	30	20	30	-	25	125

Prerequisite: Readers/students are expected to know the following concepts:
Engineering Mathematics

Course Objectives:

- To prepare the students to apply numerical methods to solve differential equations, integrations and simultaneous equations and perform regression analysis.

Course Outcomes: On completion of the course, students will be able to

1. Apply curve fitting techniques, carry out regression and interpolation analysis of any engineering problem.
2. Solve simultaneous equations using numerical technique.
3. Perform numerical integration for any engineering problem.
4. Solve differential equation of any engineering problem using numerical technique.

Unit I: Curve Fitting, Regression and Interpolation

Curve fitting with Linear Equation, Criteria for a Best Fit, Linear Least Square Regression, Linear Regression Analysis, Coefficient of Determination, Polynomial Regression, Multiple Linear Regression, Lagrange's Interpolation, Newton's Forward Interpolation, Hermit Interpolation, Inverse Interpolation

Unit II: Simultaneous Equations

Gauss Elimination Method, Partial Pivoting, Gauss Seidel Method, Gauss Jordan Method and Thomas Algorithms for Tridiagonal Matrix.

Unit III: Numerical Integration

Trapezoidal rule, Simpson's Rule ($1/3^{rd}$ and $3/8^{th}$), Gauss Quadrature2 point and 3 point method, Double Integration- Trapezoidal Rule, Simpson's $1/3^{rd}$ Rule

Unit IV: Numerical Solution of Differential Equations

Euler Method, Modified Euler Method (Iterative), Runga-Kutta Fourth Order Method, Simultaneous Equations using Runga-Kutta Second Order Method, Introduction to Finite Difference Method.

Text books:

1. Numerical methods- Rao V. Dukkipati- New Age International Publishers
2. Introductory Methods of Numerical Analysis- S.S.Sastry-University Press

Reference books:

1. Numerical Methods in Engineering with Python 3 – Jaan Kiusalaas-Cambridge University Press
2. Numerical Methods -S. Balachandra Rao and C.K.Shantha, University Press

List of Exercises

At least three assignments on each unit.

IOEUA42172E: Social Media Analytics (Open Elective - I)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2hrs./week Tutorial (T): - Practical (P): 2hrs./week	20	30	20	30	-	25	125

Prerequisites: Readers/students are expected to know the following concepts:
Basic knowledge of Graphs.
Data mining.
Data Analysis.
Python Programming

Course Objectives:

- To understand foundations of Social Media Analytics.
- To Visualize and understand the data mining aspects in social networks.
- To solve mining problems by different algorithms.
- To understand network measures for social data.
- To understand behavioral part of web applications for Analysis.
- To analyze the data available on any social media applications.

Course Outcomes: On completion of the course, students will be able to

1. Understand the basics of Social Media Analytics and develop web crawler.
2. Understand the visualization of social networks and the significance of Data mining in Social media.
3. Demonstrate the algorithms used for text mining by implementing clustering algorithms.
4. Compare and Apply network measures for social media data by implementing certain centrality measures.
5. Explain Behavior Analytics techniques used for social media data and implement local and global clustering coefficient technique.
6. Explore Facebook and Twitter API.

Unit I: Introduction to Social Media Analytics (SMA) and network Visualization

Social media landscape, Need for SMA; SMA in Small organizations; SMA in large organizations; Application of SMA in different areas, The foundation for analytics, Social media data sources, Defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics. The social networks perspective - nodes, ties and influencers, Social network and web data and methods. Graphs and Matrices- Basic measures for individuals and networks, A Taxonomy of Visualization.

Unit II: **Data and text Mining in social media**

Data mining in Social Media- Introduction, Data mining methods for Social Media

Text Mining- Introduction, Keyword search, Classification Algorithms, Clustering Algorithms-Greedy Clustering, Hierarchical clustering, k-means clustering.

Unit III: Network Measures

Centrality: Degree Centrality, Eigenvector Centrality, Katz Centrality, PageRank, Betweenness Centrality, Closeness Centrality, Group Centrality Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence.

Unit IV: Behavior Analytics

Individual Behavior: Individual Behavior Analysis, Individual Behavior Modeling, Individual Behavior Prediction

Collective Behavior: Collective Behavior Analysis, Collective Behavior Modeling, Collective Behavior Prediction

Text books:

1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press, ISBN: 10: 1107018854.
2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6.
3. Matthew Ganis, Avinash Kohirkar Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media,Pearson publications,2016

Reference Books:

1. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0. 2.
2. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615.
3. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN: 13: 978-1-55860-901-3 ISBN: 10: 1-55860-901-6.
4. Bing Liu, Web Data Mining : Exploring Hyperlinks, Contents and Usage Data, Springer, 2nd Edition, ISBN: 978-3-642-19459-7

List of Experiments:

1. Implement a web crawler using Scrapy.
2. Implement hierarchical clustering in python.
3. Implement k-means clustering in python.
4. Plot the given graph in python and calculate its Degree centrality.
5. Plot the given graph in python and calculate its Betweenness centrality.
6. Plot the given graph in python and calculate its Closeness centrality
7. For the given graph compute local and global clustering coefficient.
8. Study Assignment-Explore Twitter's API and Facebook's social graph API.

IOEUA42173A: FinTech (Financial Technology) (Open Elective – II)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): -	20	30	20	30	-	-	100

Prerequisite: NA

Course Objectives:

- To Introduce FinTech and its sub sectors
- To Explain the classification of various models of FinTech
- To Describe the innovation in FinTech
- To Introduce an innovative FinTech strategy
- To Study the development of FinTech application and about future trends in FinTech

Course Outcomes: On completion of the course, students will be able to

1. Understand what FinTech is and the sub sectors that comprise it.
2. Classify various models of the Fintech
3. Illustrate various innovations done using latest technology trends in FinTech.
4. State the critical success factors in FinTech.
5. Be able to adopt an innovative FinTech strategy within their own organization to lead a digital transformation project.
6. Develop the application using the concepts of FinTech as a case study

Unit I : Introduction to Fintech

Introduction, Financial Services and Fintech: Introduction, Changing Environment, Customer Centricity, Digital Transformation, Definition of Fintech, History of Fintech, Fintech stages, An Overview of Fintech Initiatives Around the World, Ecosystems, Ranking National Ecosystems, Downsides of Disruptive Fintech Initiatives.

Unit II : Model and Classifications

Introduction, Classification, Five Ws and one H : 1. Why a Fintech initiative was born? 2. For whom was it born? 3. Which are the services it aims to provide? 4. Where does it aim to perform its business? 5. When does it aim to operate, within the framework of the financial cycle? 6. How is Fintech working? The organization and its elements, The V4 business model framework, A Business Model, A Business Model for Fintech, Revenue—Focus on Customer Lifetime Value, Components of an effective marketing plan.

Unit III : Fintech Innovation

Introduction, Innovation and Fintech, Digital Transformation and Fintech, A model for an integrated innovation strategy, Types of Innovation : Product (or services), Process, Organization, Business models, Examples of Innovation, Fintech business model canvas, Process Innovation : Big Data Analytics, Value Creation from Big Data Analytics, Kreditech's self-learning algorithm, Internet of Things, Blockchain Technology, Organizational Innovation: Social Networks, Business Model Innovation, Robots, The V4 business model framework for Kreditech, Virtual Currencies, Technology Acceptance Model.

Unit IV: Critical Success Factors

The Model, Low-Profit Margin, Agility, Scalability, Security Management, Innovation, Ease of Compliance, Metrics, Fintech and Financial Services, Structure of fintech initiatives, The Challenges, Aspects to Consider, A Cooperation Model, Open Innovation

Unit V: Regulations

The Role of the Regulators, Equal Treatment and Competition, The Risks to Consider, Regtech, A Business Model for Insurtech Initiatives, Drivers of Disruption, The Impact of Technology, Insurance and Technology: Insurtech, Application of the Model to the Insurance Industry, The Empowerment of Customers, Mobility in Support of Insurance Companies, Digital Wholesale Insurance.

Unit VI: A Case Study

Introduction, Robotica, Business Model Canvas, The Value Proposition, Customer Experience, Channels, Processes and Activities, Resources and Systems, Partnership and Collaborations, Revenues, Costs and Investments, The Future: Financial Services as Platforms.

Text Books :

1. B. Nicoletti, The Future of FinTech, 1st ed. Palgrave Macmillan, 2017
2. Kelvin Leong and Anna Sung "FinTech (Financial Technology): What is It and How to Use Technologies to Create Business Value in Fintech Way?" International Journal of Innovation, Management and Technology, Vol. 9, No. 2, April 2018

Reference Books :

1. Accenture. (2015). The future of Fintech and banking: Digitally disrupted or reimagined? Accenture Research, 1–12
2. Dietz, M., Khanna, S., Olanrewaju, T., & Rajgopal, K. (2015). Cutting through the fintech noise: Markers of success, imperatives for banks. Practice, G. B. (Ed.), 1–18. McKinsey and Company. Retrieved from http://www.mckinsey.com/ industries/financial-services/our-insights/cutting-through-the-noise round financial -technology.
3. "What is FinTech and why does it matter to all entrepreneurs?". Hot Topics. July 2014. retrieved December 9, 2014.

IOEUA42173B: Agriculture Electronics (Open Elective – II)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): -	20	30	20	30	-	-	100

Prerequisite: Readers/students are expected to know the following concepts:
Basic Electronics devices and their operations
Basic understanding of sensors and transducers.
Basic Farming Activities.

Course Objectives:

- To empower the learner to recognize environmental problems and to provide solutions to agricultural sector.
- An over view of technology of advanced topics like DAS, SCADA and IOT.
- The ability to select the essential elements and practices needed to develop and implement the Engineering Automation for Agricultural sector.

Course Outcomes: On completion of the course, students will be able to

1. Understand Role of Instrumentation & DAS.
2. Understand basics of Sensors and transducers.
3. Describe Instrument technology used in agriculture.
4. Apply knowledge of Electronics to achieve Precision Farming.
5. To design select and justify system components for different control Farming applications
6. Understand Smart Agriculture Technology & Role of Electronics Governance

Unit I : Introduction of Instrumentation system and Data acquisitions systems (DAS)
Introduction of Instrumentation system, Block diagram,
Data loggers, Data acquisitions systems (DAS), Basics of PLC , Supervisory control and data acquisition (SCADA),

Unit II : Sensors and Transducers
Basic of sensors and transducers, Type of sensors, Performance terminology - Displacement, Velocity and Motion sensors - Proximity sensors, Force, Pressure.
Soil parameter measurement sensors - Flow, Level and Temperature sensors, Humidity, pH and Conductivity sensors, Specifications and selection criteria.

Unit III : Instrument technology for agriculture
Instruments for measurement of pH, Electrical conductivity, gas analysis, humidity, leaf area, chlorophyll content, and soil moisture & temperature.
Instrument for crop monitoring – moisture measurement – capacitive, infrared reflectance and resistance. Monitoring soil and weather – measurement of soil properties and meteorological parameters

Unit IV: Precision Farming
An introduction to precision farming. GIS/GPS positioning system for precision farming, Yield monitoring and mapping, soil sampling and analysis. Computers and Geographic information

systems. Precision farming- Issues and conditions. Role of electronics in farm machinery for precision farming. Technology for precision farming.

Unit V: Control Applications in Farming :

Irrigation control systems. Instruments for crop establishment monitoring. Crop spraying – selective crop spraying – flow control. Yield monitoring.
Instruments for protected cultivation – Green house environment control – transducers and control system. Instruments and systems for crop handling processing and storage.

Unit VI: SMART agriculture :

Introduction to IOT, IOT in Agriculture, Wireless sensor networks, IOT network using LoRaWAN. Open Agriculture Initiative (OpenAg),
Agriculture & Electronics Governance: Technological Difficulties in Indian Context, Governance products & services in agriculture sector, Role of Electronics Governance in Agricultural sector.

Text Books :

1. K. Krishna Swamy**,** "Process Control"; New Age International Publishers.
2. C.S. Rangan, G.R. Sarma, V.S.V. Mani; "Instrumentation Devices and Systems "; Tata McGraw Hill; 2nd Edition
3. Curtis Johnson, "Process Control Instrumentation Technology"; 8th Edition, Pearson Education

Reference Books :

1. Shimon Y. Nof , "Springer Handbook of Automations", Springer.
2. Ernest O. Doebelin; " Measurement System Application and Design "; Mc-Graw Hill; 5th Edition
3. David G. Alciatore, Michael B Histand; "Introduction to Mechatronics and Measurement System"; Tata McGraw Hill
4. De Mess M. N. Fundamental of Geographic Information System. John Willy & sons, New York, Datta S.K.1987

IOEUA42173C: Operations Research (Open Elective-II)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): -	20	30	20	30	-	-	100

Prerequisite: Readers/students are expected to know the following concepts:
Engineering Mathematics

Course objectives:

- To familiarize the students with various tools of optimization, probability and statistics as applicable scenarios in industry for better management of various resources

Course Outcomes: On completion of the course, students will be able to

1. Solve linear programming problems using appropriate techniques
2. Propose the best strategy using decision making methods under uncertainty and game theory
3. Apply the concept of transportation/assignment models to optimize available resources
4. Develop mathematical skill to solve inventory and replacement problems
5. Perform minimization of process time
6. Use CPM and PERT techniques, to plan, schedule, and control project activities.

Unit I - Introduction to Operations Research

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research.
Linear Programming Problem: Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, Two-phase method, Duality

Unit II – Decision Theory and Theory of Games

Decision Theory: Meaning and Steps in Decision Making, Types of Management Decisions, Decision under Certainty, Decision under Risk, Decision under Uncertainty, Decision Trees
Theory of Games: Introduction, Minimax and Maximin Principle, Solution of Game with Saddle Point, Solution by Dominance, Solution by Graphical Method, m x n size Game Problem

Unit III – Transportation and Assignment Model

Transportation Model: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.
Assignment model: Formulation. Hungarian method for optimal solution. Solving unbalanced problem

Unit IV – Inventory Control and Replacement Analysis

Inventory Control: Basic Concepts, fixed order quantity inventory model, economic order quantity inventory models, probabilistic inventory model
Replacement Analysis: Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly: Individual replacement policy, Group replacement policy.

Unit V – Queuing Theory and Sequencing Model

Queuing Theory: Introduction, Basis Structure, Terminology (Kendal's Notations), Queuing Model M/M/1: /FIFO, M/M/c.
Sequencing models: Solution of sequencing Problem - Processing of n jobs through two machines, Processing of n jobs through three machines, Processing of two jobs through m Machines, Processing of n jobs through m Machines.

Unit VI – Project Management

Fundamentals of CPM and PERT networks, CPM: Construction of networks, Fulkerson's rule , Critical paths, Forward and backward pass, Activity Float analysis, Crashing Analysis, PERT: Time estimates, Construction of networks, Probability of completing projects by given date.

Text Books:

1. Sharma S.D., "Operations Research", Kedarnath Ramnath and company publications. ISBN-13:1234567142552
2. Gupta P.K., Hira D.S., "Operations Research", S Chand and Co. Ltd., New Delhi. ISBN 13:9788121902816
3. Taha H.A., "Operations Research - An introduction", Prentice Hall Pvt. Ltd. ISBN-13: 978-0132555937

Reference Books:

1. Hillier F.S., Lieberman G.J., "Introduction to Operations Research", Tata McGraw-Hill. ISBN 978-0-07-337629-5
2. Wagner H.M., "Principles of Operations Research", Prentice-Hall India ISBN 978-0-9843378-2-8
3. Ravindran A., "Operations Research", Tata McGraw-Hill. New Delhi ISBN-13: 978-0471086086
4. Basu S.K., Pal D.K., and Bagchi H., "Operations Research for Engineers", Oxford and IBH Publishing ISBN 81-204-1251-6
5. Panneerselvam R., "Operations Research", Prentice Hall of India Ltd., New Delhi ISBN 81-203-1923-0

IOEUA42173D: Total Quality Management (Open Elective - II)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): -	20	30	20	30	-	-	100

Prerequisite: Nil

Course objectives:

- Understand the basic principles of Quality and Total Quality Management.
- Comprehend the customer satisfaction and customer involvement.
- Acquire the knowledge of quality management tools and Statistical Process Control.
- Acquire the knowledge of Management Information Systems
- Understand fundamentals of Quality standards

Course Outcomes: On completion of the course, students will be able to

1. Understand Quality, Quality circle, basic concepts and barriers of Total quality Management. **(Understand)**
2. Explain TQM principles and concepts of Six sigma. **(Understand)**
3. Understand Total productive maintenance, FMEA and apply Benchmarking, QFD, House of quality, Pareto Analysis and Poka yoke. **(Understand, Apply)**
4. Understand and Apply Statistical Process Control SPC tools **(Understand, Apply)**
5. Understand fundamentals of Quality standards (ISO) **(Understand)**
6. Understand Management Information System for an organization. **(Understand)**

Unit I - Introduction to Quality and TQM

a. Definition of Quality, Importance of quality on a project in the context of global challenges Dimensions of Quality, Quality Planning, Quality costs, Quality circle.
b. Basic concepts of Total Quality Management, Necessity and advantage, Historical Review, Contribution of Quality Gurus (Juran, Deming, Crossby, Ishikawa), Barriers of TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints – Customer retention – Costs of Quality.

Unit II – TQM principles & Six Sigma

a. Principles of TQM, Continuous Process Improvement – Juran Trilogy, PDCA, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.
b. Six sigma – Importance, levels of six sigma, Defects & it's classification in construction. Measures to prevent and rectify defects.
c.

Unit III – TQM Tools and Techniques

a. The seven tools of quality, Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Flow Charts – Pareto Analysis– Poka Yoke (Mistake Proofing)

b. Total Productive Maintenance (TPM) – Concept, Improvement Needs, Failure Mode Effect Analysis (FMEA)FMEA – Stages of FMEA

Unit IV – STATISTICAL PROCESS CONTROL (SPC)

a. Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Statistical Process Control: process flow diagram, cause and effect diagram, check sheets, histograms
b. Control charts: state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

Unit V – Quality System (ISO)

a. Need of quality systems, Study of ISO 9001 principles, Quality manual – Importance, contents, documentation. Importance of check-lists in achieving quality.
b. Corrective and Preventive actions, Quality Audits, Conformity and NC reports, TS16949, ISO 14000 – Concept, Requirements and Benefits

Unit VI – Management Information System

a. Introduction to Management Information systems (MIS) Overview, Definition. MIS and decision support systems, Information resources, Management subsystems of MIS.
b. MIS based on management activity whether for operational control, management control, strategic control. Study of an MIS for an organization

Text Books:

1. Total Quality Management-- Dr. Gunmala Suri and Dr. Puja Chhabra Sharma—Biztantra.
2. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ. Company.
3. Total Quality Management - Dr. S.Rajaram and Dr. M. Sivakumar—Biztantra.
4. Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.

Reference Books:

1. Juran's Quality Handbook – Juran Publication. Importance of quality on a project in the context of global challenges. Importance of quality on a project in the context of global challenges.
2. Management –Principal, process and practices by Bhat – Oxford University Press.
3. Financial management by Shrivastava- Oxford University Press.
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ. Co.
5. Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.

IOEUA42173E: Blockchain Technologies (Open Elective-II)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): - Practical (P): -	20	30	20	30	-	-	100

Prerequisite: Nil

Course objectives:

- To understand the basic fundamentals of Blockchain.
- To introduce Bitcoin Blockchain.
- To explain blockchain creation process
- To know the importance of Hyperledger
- To gain knowledge about the multichaining
- To discuss the emerging trends in Blockchain and Use cases

Course Outcomes: On completion of the course, students will be able to

1. Get fundamental knowledge of Blockchain
2. Know about Bitcoin Blockchain
3. Understand blockchain creation process.
4. Explore Hyperledger
5. Know Emerging Trends in Blockchain

Unit I - Overview of Blockchain

Basics of Blockchain, History of Blockchain, Network and protocols, Smart Contract and Consensus Algorithms, Blockchain users and adoption, Blockchain challenges

Unit II – Bitcoin Blockchain

Blockchain TOC Bitcoin/ Blockchain data structures, Keys as identity, Digital Signatures, Hashes, Hashes as Addresses, Hash Pointers and Data Structures, Blockchain transactions, Blockchain block structure.

Unit III – Creating the Blockchain: Mining

Mining explained, The bitcoin network, The bitcoin Minning Process, Minning Developments

Unit IV – Hyperledger

Overview of Hyperledger, Hyperledger Projects, Hyperledger Architecture, Consensus model for permissioned Blockchains, Consensus and its interaction with architectural layers, Architecture of Enterprise level Blockchain applications.

Unit V – Blockchain on Multichain

Introduction to Multichain, Privacy and Permissions in Multichain, Features of Assets in Multichain, Multichain Streams, Mining in Multichain, Interactive mode commands, Round Robin Mining

Unit VI – Emerging Trends in Blockchain and Use cases

Transaction limitations, Additional blockchains, Hyperledger, Ethereum, Ripple, R3, Blockchain and cloud computing, Cloud -Based Blockchains, Blockchain Use cases, Blockchain and Artificial Intelligence
Text Books: 1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos 2. Blockchain by Melanie Swa, O'Reilly 3. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
Reference Books: **1.** Hyperledger Fabric - https://www.hyperledger.org/projects/fabric