BansilalRamnathAgarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

Curriculum for
Final Year B. Tech.
Electronics & Telecommunication
(2018 pattern)

Department of
Electronics & Telecommunication
Engineering

VISION:

- Excellence in Electronics & Telecommunication Engineering Education

MISSION:

- Provide excellent blend of theory and practical knowledge
- Establish center 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 2018)
MODULE I

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
ETUA40181	Professional Elective -IV **(PR)**	TH	3	-	2	20	30	20	30	25	125	4
ETUA40182	Professional Elective V **(OR)**	TH	3	-	2	20	30	20	30	25	125	4
IOEUA40183	**Open Elective II (TW)**	TH	**3**	**1**		20	30	20	30	25	125	4
IOEUA40184	Open Elective III **(OR)**	TH	3	-	2	20	30	20	30	25	125	4
ETUA40185	Intellectual Property Rights (IPR)	CE	2	-	-	-	-		-	50		2
ETUA40186	Project Work	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	1	16	180	120	130	120	150	700	23

Professional Elective IV			**Professional Elective V**
Course Code	**Course Title**	**Course Code**	**Course Title**
ETUA40181A	Image and Video Processing	ETUA40182A	Deep Learning
ETUA40181B	Digital IC Design	ETUA40182B	Power Electronics and Electric Vehicles
ETUA40181C	Embedded Systems	ETUA40182C	Advanced Communication Systems
ETUA40181D	System Programming	----	-----

Open elective II		Open elective III	
IOEUA40183A	Project Planning and Management	IOEUA40184A	Robotics
IOEUA40183B	Software testing	IOEUA40184B	Quantum Computing
IOEUA40183C	5G Mobile Networks	IOEUA40184C	Business Intelligence.
IOEUA40183D	Cloud Computing	IOEUA40184F	Business Analytics
IOEUA40183E	Solar and Wind Energy	—	—

Mandatory Course: Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge, Online certification course (minimum two weeks)

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

FINAL YEAR B. TECH (E&TC ENGINEERING), SEMESTER VII (PATTERN 2018) MODULE II

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
ETUA40187	Semester Internship (OR)	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	24	100	-	-	-	50	150	12

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

FINAL YEAR B. TECH (E&TC ENGINEERING), SEMESTER VIII (PATTERN 2018)
MODULE III

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
ETUA42181	Professional Elective VI**(OR)**	TH	3	-	2	20	30	20	30	25	125	4
IOEUA42182	Open Elective IV **(TW)**	TH	2	-	2	20	30	20	30	25	125	3
IOEUA42183	Open Elective V **(TW)**	TH	2	-	2	20	30	20	30	25	125	3
ETUA42184	Introduction to Research**(TW)**	CE	1	-	2	--	-	-	-	25	25	2
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	8	-	8	60	90	60	90	100	400	12

Professional Elective VI		**Open Elective IV**	
Course Code	**Course Title**	**Course Code**	**Course Title**
ETUA4281A	High Performance Computing	IOEUA42182A	Engineering Economics
ETUA42181B	Computer Vision and Deep Learning	**Open Elective V**	
ETUA42181C	Analog IC Design	IOEUA42183B	Inferential Statistics for Data Science
ETUA42181D	Artificial Intelligence		

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

FINAL YEAR B. TECH (E&TC ENGINEERING), SEMESTER VIII (PATTERN 2018) MODULE IV

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
ETUA40187	Semester Internship	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	24	100	-	-	-	50	150	12

FINAL YEAR B. TECH (E&TC ENGINEERING), SEMESTER VIII (PATTERN 2018) MODULE V

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
ETUA40181	Professional Elective -IV **(PR)**	TH	3	-	2	20	30	20	30	25	125	4
ETUA40182	Professional Elective V **(OR)**	TH	3	-	2	20	30	20	30	25	125	4
IOEUA40183	**Open Elective II (TW)**	TH	**3**	**1**	**-**	20	30	20	30	25	125	4
IOEUA40184	Open Elective III **(OR)**	TH	3	-	2	20	30	20	30	25	125	4
ETUA40185	Intellectual Property Rights (IPR)	CE	2	-	-	-	-	50	-	-	50	2
ETUA40186	Project Work	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	1	16	180	120	130	120	150	700	23

Mandatory Course: Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge

Professional Elective IV			**Professional Elective V**
Course Code	**Course Title**	**Course Code**	**Course Title**
ETUA40181A	Image and Video Processing	ETUA40182A	Deep Learning
ETUA40181B	Digital IC Design	ETUA40182B	Power Electronics and Electric Vehicles
ETUA40181C	Embedded Systems	ETUA40182C	Advanced Communication Systems
ETUA40181D	System Programming	----	-----
Open elective II		**Open elective III**	
IOEUA40183A	Project Planning and Management	IOEUA40184A	Robotics
IOEUA40183B	Software testing	IOEUA40184B	Quantum Computing
IOEUA40183C	5G Mobile Networks	IOEUA40184C	Business Intelligence
IOEUA40183D	Cloud Computing	IOEUA40184F	Business Analytics
IOEUA40183E	Solar and Wind Energy	—	—

Nomenclature

L	Lectures/week
T	Tutorial/week
P	Practicals /week
CIE	Continuous Internal Evaluation
ISE	In Semester Examination
SCE	Skills and Competency Evaluation
ESE	End Semester Evaluation

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

Semester VII/VIII

Professional Elective-IV
ETUA40181A: Image and Video Processing

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR	TW	Total
Lecture (L): 3 hrs./week Tutorial (T): 0 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: 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 (6 Hours)

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 (6 Hours)

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 (6 Hours)

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

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(6 Hours)

Types of redundancy, Bit-plane coding, lossless versus Lossy compression, Introduction to DCT, Wavelet transforms, Lossy compression – DCT based compression, Introduction to JPEG, Image Degradation/Restoration Process, Noise models and Restoration of images degraded due to noise, Inverse and Wiener Filtering

Unit VI: Fundamentals of video Processing(6 Hours)

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 4th Edition
2. Iain E. G. Richardson, ―H.264 and MPEGVideo 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

Image and Video Processing (List of experiments) (Any 8)*

1. Introduction toScikit 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

* Open source libraries will be used for the experiments

Professional Elective IV
ETUA40181B: Digital IC Design

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR	TW	Total
Lecture (L): 3 hrs./week Tutorial (T): 0 Practical (P):2 hrs/week	20	30	20	30	25	--	125

Prerequisite: Students are expected to know the concepts studied in following courses:
1. Electronic Devices and Circuits
2. Digital System Design

Course Objectives:

- To get acquainted with CMOS fabrication technology.
- To realize importance of delay and power dissipation in VLSI circuit design.
- To nurture students with digital CMOS and SOI circuit designs.
- To realize importance of testability in logic circuit design.

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

1. Apply knowledge of physics, mathematics, and electronics to learn the theory of MOS transistors.
2. Understand CMOS IC fabrication process.
3. Know the trade-off between delay and power dissipation.
4. Design combinational and sequential CMOS circuits.
5. Use techniques, skills, and modern engineering tools necessary for design and simulation of CMOS circuits.
6. Apply knowledge of testability to design digital CMOS circuits.

Unit I : MOS Transistor Theory (6 Hours)
Introduction, Ideal I-V characteristics, C-V characteristics, Non-ideal I-V effects, DC transfer characteristics.

Unit II: Overview of CMOS Technology (6 Hours)
Fabrication process flow, Wafer processing, Photolithography, Oxidation, Ion implantation, Deposition and Etching.

Unit III: Delay Models and Power Dissipation (6 Hours)
Delays: RC delay model, Linear delay model, Logical effort, Parasitic delay, Power Dissipation: Sources of power dissipation, Dynamic power, Static power, Energy-Delay optimization.

Unit IV : Combinational Circuit Design (6 Hours)
Static CMOS: CMOS inverter, DC transfer characteristics, CMOS NAND and NOR gates, Compound gates, Layout design rules, Stick diagram and layout design, Pass transistor and Transmission gate circuits.

Unit V: SOI and Sequential Circuit Design **(6 Hours)**

Silicon-On-Insulator circuit design, Floating body voltage, SOI advantages and disadvantages, Implications for circuit styles, Sequencing static circuits, Circuit design of latches and flip-flops.

Unit VI: Design for Testability **(6 Hours)**

Fault models, Observability, Controllability, Fault coverage, Scan design, BIST, Boundary scan: TAP Architecture and TAP Controller.

Text Book :

1. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design: A Circuit & System Perspective," 4th Edition, Pearson.

Reference Books :

1. Jan M. Rabaey, AnanthaChandrakasan, and BorivojeNikolic, "Digital Integrated Circuits: A design perspective," 2nd Edition, Pearson.
2. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design," TMH.

List of Experiments:

After completion of this course student should be able to

1. do SPICE modeling of digital circuits using modern tools.
2. prepare layout of digital CMOS circuits and verify the functionality using modern tools.

(A) To do SPICE modeling of following circuits at selected technology node.

1. NMOS and PMOS transistor characterization.
2. CMOS inverter.
3. 2-input CMOS NAND and NOR gate.
4. D Flip-flop

(B) To prepare CMOS layout in selected technology, simulate with and without capacitive load.

1. CMOS inverter.
2. 2-input CMOS NAND and NOR gate.
3. 2:1 multiplexer using transmission gates.
4. D Flip-flop

Mini Project/Seminar (SCE)

Professional Elective IV

ETUA40181C: Embedded Systems

Teaching Scheme	Examination Scheme						
Credits: 04	CIE	ISE	SCE	ESE	PR	TW	Total
Lecture (L): 03hrs./week Tutorial (T): - Practical (P): 02 hrs/week	20	30	20	30	25	--	125

Prerequisite: Students are expected to know the concepts studied in following courses:

1. Microcontroller Application
2. Data Structure
3. Assembly / C programming

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 with advanced architecture
- 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: At the end of this course, students will demonstrate the ability to

1. Identify techno commercial aspect of embedded system design
2. understand usage of advanced architecture for embedded system
3. Understand the difference used in RTOS and GPOS w.r.t real time system
4. Program embedded application using RTOSµcos-II.
5. Use Linux for embedded system development
6. Understand embedded system design components through case studies

Unit- I: Embedded System Overview (6 Hrs)

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: Advanced architecture overview (6 Hrs)

ARM Design, LPC 2148 and LPC 1768 architecture, advantages for embedded systems, system control configuration, GPIO exploration, on chip peripheral control

Unit –III: Real time system and RTOS (6 Hrs)

Real time system, types, design approaches and considerations, Usage ofShared resourcesand 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(6 Hrs)

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 (6 Hrs)

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 Embedded/real time system (Hardware, Algorithm and software) (6 Hrs)

1. Communication bridge
2. Automated real time control systems
3. Adaptive Cruise Control System

Text Books :

1. Frank Vahid and Tony Givargis, "Embedded System Design – A Unified hardware/ Software introduction" 3rdedition, Wiley
2. LPC 2148 and LPC 1768 user manual
3. Jean Labrosse, "µcos-II, The Real-Time Kernel", 2ndedition, CMP Books.
4. 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" 2ndedition s.

List of Experiments:

After completion of this course student should be able to

1. Design and implement application specific system on ARM architecture.
2. Design and implement RTOS based Real time system on ARM architecture

1.Porting exercise ofµcos-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

Mini Project/Seminar (SCE):

Evaluation proposed for SCE in the course is as follows:

Broad Perspective: As syllabus of the course expect to develop an ability for using OS services for an application, SCE is proposed as an **ABET problem** as practical demonstration for the same.

Problem statement: Design and develop an embedded application of your choice that uses at least three services of OS/RTOS (Real Time OS)/Embedded Linux.

Evaluation Scheme: Above statement will be performed in a group of **two /Three students** and will be evaluated **individually** through technical document (Report), implementation details (Hardware/Simulation) and short seminar.

Professional Elective IV
ETUA40181D: System Programming

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

Prerequisite: Students are expected to know the concepts studied in following courses:

1. Data Structures
2. Design and Analysis of Algorithms
3. Operating Systems

Course Objectives:

- To introduce language processing fundamentals and assemblers.
- To explain design of macro processors.
- To introduce loaders and Linkers
- To introduce compiler design process
- To explain working of syntax analyzer.
- To introduce different code optimization methods

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

1. Develop hypothetical assembler. (Apply)
2. Illustrate macro processors(Understand)
3. Illustrate linkers and loaders. (Understand)
4. Implement lexical analyzer using LEX tool (Apply)
5. Build parser using YACC tool (Apply)
6. Demonstrate code optimization and code generation concept (Understand)

Unit- I: Introduction to Systems Programming And Assemblers(6 Hrs)

Introduction: Need of System Software, Components of System Software, Language Processing Activities, Fundamentals of Language Processing.

Assemblers: Elements of Assembly Language Programming, A simple Assembly Scheme, Pass structure of Assemblers, Design of Two Pass Assembler, Single pass assembler.

Unit- II: Macroprocessors(6 Hrs)

Macro Definition and call, Macro expansion, Nested Macro Calls, Advanced Macro Facilities, Design of a macro-processor.

Unit –III: Loaders And Linkers (6 Hrs)

Loaders: Loader Schemes, Compile and Go, General Loader Scheme, Absolute Loader Scheme, Subroutine Linkages, Relocation and linking concepts, Self-relocating programs, Relocating Loaders, Direct Linking Loaders, Overlay Structure.

Unit - IV: Introduction to Compiler (6 Hrs)

Compilers and Interpreters: Structure of Compiler, Concepts of Pass, Phases, front-end and back-end, Concepts of Bootstrap compiler.

The Role of the Lexical Analyzer, Input Buffering. Specification of Tokens, Recognition Tokens, Design of Lexical Analyzer using Uniform Symbol Table, Lexical Errors. LEX: LEX Specification, Generation of Lexical Analyzer by LEX.

Unit V: Parsers (6 Hrs)

Role of parsers, Classification of Parsers: Top down parsers- recursive descent parser and predictive parser (LL parser), Bottom up Parsers – Shift Reduce parser, LR parser. YACC specification and Automatic construction of Parser (YACC).

Unit VI: Code Generation and Optimization (6 Hrs)

Code Generation: Code generation Issues. Basic blocks and flow graphs, A Simple Code Generator. Code Optimization: Machine Independent: Peephole optimizations: Common Sub-expression elimination, Removing of loop invariants, Induction variables and Reduction in strengths, Use of machine idioms, Dynamic Programming Code Generation. Machine dependent Issues: Assignment and use of registers.

Text Books:

1. D. M. Dhamdhere, Systems Programming and Operating Systems, Tata McGrawHill, ISBN 13:978-0-07-463579-7, Second Revised Edition
2. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Compilers Principles, Techniques and Tools, Addison Wesley, ISBN:981–235–885 - 4, Low Price Edition
3. John R. Levine, Tony Mason & Doug Brown, "Lex&Yacc", O'Reilly

Reference Books:

1. J. J. Donovan, Systems Programming, McGraw-Hill, ISBN 13:978-0-07-460482- 3, Indian Edition

List of Experiments:

After completion of this course student should be able to

1. To design and implement two pass assembler for hypothetical machine instructions
2. To design and implement different phases of compiler (Lexical Analyzer, Parser, Intermediate code generation)
3. To use the compile generation tools such as "Lex" and "YACC".

1. Write a program to implement Pass-I of Two-pass assembler for Symbols and Literal processing
2. Write a program to implement Pass-II of Two-pass assembler for output of Assignment 1
3. Design suitable data structures & implement first pass of a two-pass Macro processor
4. Design suitable data structures & implement second pass of a two-pass Macro processor
5. Write a program to implement a lexical analyzer
6. Write a program to implement a Recursive Descent Parser

Mini Project/Seminar (SCE)

Professional Elective V
ETUA40182A: Deep Learning

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

Prerequisite:

1. Machine Learning
2. Basics of Statistics and Probability
3. Linear Algebra

Course Objectives:

- To equip students with the basic understanding of the fundamental concept unsupervised learning.
- To understand concepts of Recurrent Neural Networks and Variants and apply them in text classification and time series forecasting.
- 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:

At the end of the course, students will be able to

1. Develop the Convolutional neural networks and YOLO based object and face recognition applications.
2. Design and Evaluate Recurrent Neural Networks, Long Short Term Memory and apply them in Natural Language Processing.
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 (6 Lectures)

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 : Recurrent Neural Networks (6 Lectures)

RNN: - One hot word representation, word embedding, word to Vec, Bidirectional RNN, Vanishing Gradient Problem, LSTM and applications, Time series forecasting with RNNs. ,Gated Recurrent Units

Unit III : Auto encoders (6 Lectures)

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

Unit IV : Variational Auto encoders (VAE) (6 Lectures)

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) (6 Lectures)

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 (6 Lectures)

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 :

3. 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, GANs, variational autoencoders, deep reinforcement learning, policy gradients, and more*. PacktPublishing Ltd, 2018.
3. Michelucci, Umberto. *Advanced applied deep learning: convolutional neural networks and object detection*. Apress, 2019.

Reference Books :

5. 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) Programming for Visualization of CNN's.

2) 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.

3) Implementation of RNN for text Classification.

4) Develop and test Autoencoder for MNIST data.

5) Implement and test Variational Auto encoder /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/Seminar (SCE)
Design and coding of an application based on the topics studied in this course.

Professional Elective V
ETUA40182B: Power Electronics and Electric Vehicles

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	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-traindesign

Unit- I: History and development of on-road Electric Vehicles (EV)(6 Hrs)

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(6 Hrs)

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(6 Hrs)

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(6 Hrs)

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(6 Hrs)

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(6 Hrs)

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 HallIndia,
2. Ali Emadi, Handbook of Automotive Power Electronics and Drives, Taylor &Francis
3. ChrisMI,M.AbulandDavidWenzhongGao,HybridElectricalVehiclePrinciplesandApplication with PracticalPerspectives**.**

Reference Books :

1. Iqbal Husain, Electric and Hybrid Vehicles DesignFundamentals
2. VedamSubramaniam, Electric Drives: Concepts and Applications,TMH
3. John M. Miller , Propulsion System for HybridVehicle
4. Bimal K Bose, Modern Power Electronics and AC Drives, PearsonEducation
5. MehrdadEhsani,YiminGaoandAliEmadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory andDesign

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-Ionbatteries
2. Compare using simulation of charge – discharge cycle of different batteries used inEVs.
3. MATLAB / Simulink model of Electric Vehicle DC power distributionsystem
4. MATLAB / Simulink modeling of Electric VehiclePowertrain
5. Modeling Re-generative braking system for ElectricVehicle
6. BLDC motor drive for Electric Vehicles – Simulation and demonstration ofdrive.
7. Compare torque-speed characteristics of BLDC and Induction motors usingsimulation
8. Time-based dynamic simulations of steering, ride, and handling using matlab /Simulink.
9. Performance analysis of Induction Motor drive for ElectricVehicle.
10. Study of Charging Station for ElectricVehicles.

Professional Elective V
ETUA40182C: Advanced Communication System

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	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:

Course Outcomes

- Understand radar fundamentals and analysis of the radar signals.
- To learn various radars like MTI, Doppler and tracking radars and their comparison.
- Identify the constituents and the challenges in network coverage and routing for energy efficiency- of Wireless Sensor Networks
- Define node Architect for specific applications
- Conceptualize the SDR and implementation details
- Identify the challenges in the maintenance of SDR

Unit I(6 Hrs)

Introduction to radar, radar block diagram and operation, radar frequencies, Applications of radar, Radar Equation, MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar, Delay Line cancellers, Staggered Pulse Reception Frequencies, Doppler Filter Banks, Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance.

Unit II(6 Hrs)

Tracking Radar: sequential lobbing, conical scan, mono-pulse Tracking, low angle tracking, tracking in range. Ground Penetrating Radar for close sensing Radar Tomography and Radar based Microwave Imaging , Emerging and Modern Applications of Radar Principles

Unit III(6 Hrs)

Wireless Sensor Network Introduction, Constraints and Challenges, Opportunities and Challenges in Wireless Sensor Networks, Advantages of Sensor Networks (Energy Advantage and Detection Advantage), Sensor Network Applications, Smart Transportation, Collaborative Processing, Key Definitions

Unit IV(6 Hrs)

Sensor Network Architecture and Applications Introduction, Functional Architecture for Sensor Networks, Sample Implementation Architectures, Classification of WSNs, Characteristics, Technical Challenges, and Design Directions, Technical Approaches, Coverage in Wireless Sensor Networks, Location in Wireless Sensor Networks, Data Gathering and Processing

Unit V(6 Hrs)

Software Defined Radio, Introduction – Software Defined Radio – A Traditional Hardware Radio Architecture – Signal Processing Hardware History – Software Defined Radio Project Complexity. A Basic Software Defined Radio Architecture Hybrid Radio Architecture- Basic Software Defined Radio Block Diagram- System Level Functioning Partitioning-Digital Frequency Conversion Partitioning. RF System Design – Introduction- Noise and Channel Capacity- Link Budget- Receiver Requirements

Unit VI(6 Hrs)

Software Architecture and Components – Introduction- Major Software Architecture Choices – Hardware – Specific Software Architecture- Software Standards for Software Radio-Software Design Patterns- Component Choices- Real Time Operating Systems- High Level Software Languages-

Hardware Languages. Smart Antennas Using Software Radio- Introduction- 4G smart Antenna Requirements Phased Antenna Array Theory- Applying Software Radio Principles to Antenna Systems Smart Antenna Architectures- Optimum Combining/ Adaptive Arrays- DOA Arrays- Beam Forming for CDMA- Downlink Beam Forming

Text Books

1. Merrill I. Skolnik "Introduction to Radar Systems", 3rd edition, Mcgraw Hill, 2017.
2. Richards, M. A., Scheer, J. A., and Holm, W. A., "Principles of Modem Radar: Basic Principles", 1st edition, Scitech Publishing, 2013.
3. Radar Systems Analysis and Design using MATLAB, B.R.Mahafza, 3rd Edition, CRC Press, 2013
4. Wireless Sensor Networks: F. ZHAO, C GUIBAS, Elsevier, Morgan Kaufmann,
5. Hand book of Sensor Networks, MOHAMMAD ILYAS, IMAD MAHGOUB,CRC Press,
6. Tony J Rouphael, RF and DSP for SDR, Elsevier Newnes Press
7. Paul Burns, Software Defined Radio for 4G, Artech House

List of Experiments: any 8 experiments

1. To Study the Design and Performance analysis of Radar Scanning And Tracking Systems.(using simulation software e.g. MATLAB)
2. To study the design and performance analysis of Doppler RADAR System. .(using simulation software e.g. MATLAB)
3. Simulating a Wireless Sensor Network (Using Advanced network Technologies Virtual Lab)
4. Basics of IoT programming using Arduino platform(e.g. Sensing data using the MKR1000 board
5. Study GNU radio
   i. Graphical tool for creating signal flow graphs and generate flow source code
   ii. Study , download, install GNU radio libraries
6. Addition and multiplication of signals
7. To create narrowband frequency modulation transmitter and receiver using GNU Radio
8. To create wideband frequency modulation transmitter and receiver using GNU Radio
9. Build BPSK modem using GNU Radio
10. Build QPSK modem using GNU Radio
11. Video transmission with GMSK using GNU Radio
12. Implementation of OFDM using GNU Radio

Open Elective II
IOEUA40183A: Project Planning and Management

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): 1 hr/week Practical (P): -	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Course Objective(s):

1. To impart knowledge of project life cycle.
2. To introduce students to Project Identification Process, Project Initiation, Pre-Feasibility Study and Project feasibility Studies,
3. To construct CPM, PERT network for a project.
4. To introduce students to Steps in Risk Management, Risk Identification, Risk Analysis and Reducing Risks
5. To introduce students to process of project Performance Measurement, Evaluation and closeout.

Course Outcomes:

Upon completion of the course, students will be able to

1. Understand what a Project is, Essential of Project Management.
2. Understand the Project Identification Process, Project Initiation, Pre-Feasibility Study and Project feasibility Studies,
3. Learn and Apply project planning and controlling techniques.
4. Identify risks in a project and strategies for managing the project risks
5. Understand project risk Management and Quality control in a project.
6. Understand the process of project Performance Measurement, Evaluation and closeout.

Unit I: Basics of Project Management

Introduction, Need, Project Management Knowledge Areas and Processes, Concept of Organizational Structure and types, The Project Life Cycle (preferably with case study), Essentials Project Management Principles.

Unit II: Project Identification and Selection

Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point. Case study is preferred

Unit III: Project Planning and controlling

Introduction, Need for Project Planning, Work Breakdown Structure (WBS), LOB, CPM and PERT, Resource Allocation, Monitoring and Control of project, Crashing, Resource Leveling, Updating

Unit IV: Project Risk Management

Identifying potential risks in a project, categorizing of project risks, and defining the strategies for managing the project risks

Unit V: Project Monitoring

Project monitoring Progress reporting, review meetings and report. Common causes of schedule delays, measuring productivity, methods of enhancing productivity, issue in project delays, Concept of quality, aspects of quality, quality control and assurance, inspection, preparation of manuals and checklists

Unit IV: Project Performance Measurement, Evaluation and closeout
Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Project Close-out, Steps for Closing the Project, Project Termination, and Project Follow-up. Case study is preferred
Term Work:
Assignments on all units
Textbooks:
1. Operations Research by Premkumar Gupta and D.S.Hira, S. Chand Publications (2014) 2. Project Management – K Nagrajan – New age International Ltd. 3. Project Management – Ahuja H.N. – John Wiely, New York. 4. Project Management-Planning and Control---Rory Burkey 4th ed.—Wiley, India.
Reference Books:
1. Project Risk Management - Bruce Barkley- McGraw-Hill, 2004

Open Elective II
IOEUA40183B: Software Testing

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T):-1 hr/Week Practical(P):	20	30	20	30		25	125

Prerequisites :

- Software Engineering, Java Programming

Course Objectives :

1. To study and understand software testing terminologies and framework,
2. To study and understand the basics of software testing life cycle.
3. To study and understand test and defect management
4. To study and understand an automation testing
5. To study and understand an automation testing tools
6. To study and understand automation testing for web application

Course Outcomes:

After completion of the course, student will be able to

1. Understand complete software testing life cycle and various terms and technologies used in testing domain
2. Demonstrate understanding of generating test plan and designing test cases
3. Demonstrate understanding of test and defect management process
4. Demonstrate understanding of automation testing
5. Create test script and execute automated tests using Selenium IDE
6. Create test script and execute automated tests using TestNG Framework

Unit I:	**Introduction to Testing**
Why is testing necessary? What is testing? Role of Tester, Testing and Quality, Overview of Software Testing Life Cycle, V model, SDLC vs STLC, different stages in STLC, document templates generated in different phases of STLC, different levels of testing, different types of testing	
Unit II:	**Basics of test design techniques**
Static techniques, reviews, walkthroughs, Various test categories, test design techniques for different categories of tests. Designing test cases using MS-Excel.	
Unit III:	**Test and Defect Management**
Test Management: Documenting test plan and test case, effort estimation, configuration management, project progress management. Use of Testopia for test case documentation and test management. **Defect Management** Test Execution, logging defects, defect lifecycle, fixing / closing defects. Use of Bugzilla for logging and tracing defects.	
Unit IV :	**Basics of Automation testing**
Introduction to automation testing, why automation, what to automate, tools available for automation testing.	

Unit V :	Automation testing using Selenium
Understanding to Selenium, using Selenium IDE for automation testing, using Selenium Web driver for automation testing.	
Unit VI :	**Automation testing using TestNG Framework**
Understanding TestNG framework, Automation testing using TestNG Framework.	

Text Books :

1. M G Limaye, "Software Testing Principles, Techniques and Tools", Tata Mcgraw Hill, ISBN: 9780070139909 0070139903
2. Srinivasan Desikan, Gopalswamy Ramesh, "Software Testing Principles and Practices", Pearson, ISBN-10: 817758121X

Reference Books :

1. Naresh Chauhan, "Software Testing Principles and Practices ", OXFORD, ISBN-10: 0198061846. ISBN-13: 9780198061847
2. Dr.K.V.K. Prasad , "Software Testing Tools", Dreamtech Press ISBN: 10:81-7722-532-4

List of assignment:

With intent to get some exposure in the software testing domain, students apply Technical, Behavioral, Process concepts learnt in the course by executing near real-life project and working in teams (project teams will ideally comprise of 4 members)

There will be 3 projects:
Project 1: Use of Testopia for test case management. The project will consists of test plan, test design for a sample web application and maintaining Requirement Traceability Matrix using the tool
Project 2: Use of Bugzilla for defect management. The project will include execution of tests designed in previous project, identifying, logging and tracing the defect and maintaining the Requirement Traceability Matrix
Integrated Project: Use of Selenium for automation testing. The project will consists of identifying which tests from project 1 can be automated, then creating script for those tests using tool, executing the tests with the help of tool and generating report for the tests cases.

Open Elective II
IOEUA40183C: 5G Mobile Networks

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): -1hr/week Practical (P):	20	30	20	30	-	25	125

Prerequisite: Students are expected to know the concepts studied in following courses:

1. Basics of Analog and Digital Communication
2. Basics of Mobile Communication
3. Basics of Networking

Course Objectives:

- To understand evolution of 5G technologies with its challenges
- To describe 5G cellular structure and design to achieve appropriate gain
- To discuss fundamentals of 5G functional and physical architecture and its requirements
- To understand design principles for multi-user communications
- To design and interpret the 5g Use cases

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

1. Understand evolution of 5G technologies with its challenges
2. Interpret the 5G cellular structure and design to achieve appropriate gain
3. Illustrate and explain the 5G functional and physical architecture and its requirements
4. Comprehend the Radio access technology in 5G
5. Understand Cooperation in 5G systems and analysis in terms of QOS
6. Design and analysis of 5G Use Cases

Unit- I: Drivers For 5G(6 Hrs)

Historical Trend for Wireless Communication - Mobile Communications Generations: 1G to 4G – Evolution of LTE Technology to Beyond 4G – Pillars of 5G – Standardization Activities -Use cases and Requirements – System Concept – Spectrum and Regulations: Spectrum for 4G – Spectrum Challenges in 5G – Spectrum Landscape and Requirements – Spectrum Access Modes and Sharing Scenarios(R1)

Unit- II: Small Cells for 5G Mobile Network(6 Hrs)

Introduction to Small Cells, WiFi and Femtocells as Candidate Small- Cell Technologies ,performance-Indoor and Outdoor, Capacity Limits and Achievable Gains with Densification , Gains with Multi-Antenna Techniques, Gains with Small Cells,DemandvsCapacity,Small Cell challenge
(R1)

Unit –III: 5G Architecture And Channel Models(6 Hrs)

5G Architecture: Software Defined Networking, Network Function Virtualization , Basics about RAN Architecture ,High-Level Requirements for 5G Architecture ,Functional Architecture and 5G Flexibility ,Physical Architecture and 5G Deployment

5G wireless propagation channel models: Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, The METIS channel models, Map-based model, Stochastic model(R2)

Unit IV : - 5G Radio-Access Technologies and Millimeter wave communication(6 Hrs)

Access design principles for multi-user communications, Multi-carrier with filtering: a new waveform, Non-orthogonal schemes for efficient multiple access, Radio access for dense deployments, Radio access for V2X communication
Millimeter Wave Communication: Channel Propagation – Hardware Technologies for mmW Systems – Deployment Scenarios – Architecture and Mobility – Beamforming – Physical layer Techniques.

Unit V: Cooperation for Next GenerationWireless Networks(6 Hrs)
Introduction to Cooperative Diversity and Relaying Strategies ,Cooperation and Network Coding,Cooperative ARQ MAC Protocols,PHY Layer Impact on MAC Protocol Analysis ,Impact of Fast Fading and Shadowing on Packet,Reception for QoSGuarantee,Impact of Shadowing Spatial Correlation

Unit VI: 5G Use Cases and Deployment(6 Hrs)
NB-IoT Devices, Smart Parking, Smart City, Smart Home, Message Queue Telemetry Transport (MQTT), MQTT telemetry. NB-IoT Baseline Deployment, Deployment bands and modes

Text Books :
1. Jonathan Rodriguez "Fundamentals of 5G Mobile Networks",Wiley Publication
2. AfifOsseiran, Jose F . Monserrat, Patrick Marsch"5G Mobile and Wireless Communications Technology",Cambridge University Press.
3. Hossam Fattah "5G LTE NarrowbandInternet of Things(NB-IoT),CRC Press

Reference Books :
1. Fei Hu, "Opportunities in 5G Networks: A research& development perspective", CRC Press
2. KrzysztofWesolowski, "Mobile Communication Systems", Wiley Student Edition
3. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press
4. AdityaJagannatham, "Principles of Modern Wireless Communication Systems"

List of Tutorials/ Experiments:
1. NS-3 simulation basics. Basic client server paradigm
2. Study of TCP internals and the difference between each of the variants. NS-3 tracing mechanism
3.Study of Queues, packet drops and their effect on congestion window size
4.Study ofOptimised Link State Routing(MANETS)
5. Study of 802.11 working with and without RTS/CTS. An insight into why its hard to setup efficient wireless networks.
6. Study of effect of Radio channel models transmission. An insight into Identifying the channel model that is more appropriate for each case (indoor, outdoor, LoS, NLoS, etc.).
mm Wave network simulator project implementation

Mini Project/Seminar (SCE)

Open Elective II
IOEUA40184D: Cloud Computing

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3hrs./week Tutorial (T): -1hr/week Practical (P):	20	30	20	30	-	25	125

Prerequisites : Computer Networks

Course Objectives:

- To understand cloud computing concepts.
- To study supporting technologies of cloud.
- To study open research problems of cloud computing.
- To study various platforms for cloud computing.
- To explore the applications based on cloud computing.
- To study and evaluate the contemporary technologies in cloudcomputing.

Course Outcomes:

After completion of the course, student will be able to

- Summarize the basic concepts of cloud computing(Remember)
- Explore the supporting technologies of cloud computing(Understand)
- Analyze the challenges and opportunities in the cloud computing(Analyze)
- Use the cloud services for deployment of his own applications(Create)
- How technologies are interrelated and use with each other(Apply)
- To explore future trends of cloud computing(Evaluate)

UNIT I - Basics of Cloud Computing **6Hrs**

Overview, Applications, Intranets and the Cloud. Your Organization and Cloud Computing- Benefits, Limitations, Security Concerns. Software as a Service (SaaS)- Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Benefits of Paas Solutions, Disadvantages of PaaS Solutions. Infrastructure as a Service (IaaS)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy
Case Study: Google Cloud Platform

UNIT II–Virtualization **6Hrs**

Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Types of

Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation. Common Standards: The Open Cloud Consortium, Open Virtualization Format. Standards for Security. Case study : VirtualBox, vmware
UNIT III - Data Storage and Security in Cloud 6Hrs
Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo Cloud data stores: Datastore and Simple DB Cloud Storage-Overview, Cloud Storage Providers. Case study: Firebase. Securing the Cloud- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Disaster Recovery- Understanding the Threats. Case study: Discuss research problems of cloud security
UNIT IV - Amazon Web Services 6 Hrs
Services offered by Amazon Hands-on Amazon, EC2 - Configuring a server, Virtual Amazon Cloud, AWS Storage and Content Delivery Identify key AWS storage options Describe Amazon EBS Creating an Elastic Block Store Volume Adding an EBS Volume to an Instance Snap shooting an EBS Volume and Increasing Performance Create an Amazon S3 bucket and manage associated objects. AWS Load Balancing Service Introduction Elastic Load Balancer Creating and Verifying Elastic LoadBalancer.
UNIT V - Ubiquitous Clouds and the Internet of Things 6 Hrs
Introduction to Ubiquitous computing, Cloud Trends in Supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud, Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS), Innovative Applications of the Internet of Things (Smart Buildings and Smart Power Grid, Retailing and Supply-Chain Management)
UNIT VI -Future of Cloud Computing 6 Hrs
Docker at a Glance: Process Simplification, Broad Support and Adoption, Architecture, The Docker Workflow. Docker compose file, Docker volume, Docker storage. Kubernetes : introduction to Kubernetes, Features of Kubernetes, Kubernetes API, Basic Architecture, Minikube.

Textbooks:	1. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, TheMcGraw-Hill. 2. Dr.KrisJamsa,"CloudComputing:SaaS,PaaS,IaaS,Virtualizationandmore" , Wiley Publications, ISBN: 978-0-470-97389-9 3. GautamShrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications, Cambridge University Press, ISBN: 9780511778476 4. Docker Documentation(https://docs.docker.com/get-started/) 5. Kubernetes Documentation(https://kubernetes.io/docs/home/)
Reference Books:	Dr. Kumar Saurabh,"Cloud Computing", Wiley Publication, ISBN10: 8126536039 Buyya, "Mastering Cloud Computing", Tata McGraw Hill, ISBN-13: 978-1-25-902995-0 Barrie Sosinsky,"Cloud Computing", Wiley India, ISBN: 978-0-470-90356-8 KailashJayaswal, "Cloud computing", Black Book, Dreamtech Press Thomas Erl, ZaighamMahmood and Ricardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Pearson, 1st Edition, ISBN :978 9332535923, 9332535922 Tim Mather, Subra K, ShahidL.,Cloud Security and Privacy, Oreilly, ISBN-13 978-81-8404-815-5

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the elective courses.

1. Case study on Case Study: Google CloudPlatform
2. Write a web based application and useFirebase.
3. Create a sample web based application using PhP/Pyhton and deploy iton AWS.
4. Assignment to install and use Docker. Create Dockerfile.
5. Assignment to install and useKubernetes.

Open Elective II
IOEUA40183E: Solar and Wind Energy

Teaching Scheme	Examination Scheme						
Credits:3 Lecture (L): 3hrs./week Tutorial (T): 1 hr/week Practical (P): ---	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	100

Prerequisite: Basic Mechanical Engineering, Basic Electrical and Electronics Engineering and Heat Transfer

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:

After successful completion of the course, student will be able to

1. Understand solar radiation and geometryprinciples.
2. Apply aspects of solar thermal system and its practicalapplications.
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 existingsystem.

Unit I : Solar Energy Basics

Present solar energy scenario in India, 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 Cell Operation

Solar Spectrum, Solar Radiation Spectrum, Worked Problem - Total Irradiance, Solar Cell Fundamentals, Worked Problem - The I-V Characteristic, Solar Cell Types and Technologies, Multi-junctions. Conversion Efficiency Limitations, Worked Problem - Solar Cell under Concentration, From Cell to Module, Energy Audit of Home/Residence

Unit III: Design of Solar PV Systems

PV Sizing and Output, Orientation and Tilt, Temperature Dependent Output, Temperature Dependent Output asaPercent, Module andarrayconditions, Shading calculations using PV Watts, PV Sizing and output under different conditions, Inverter Sizing and Selection, CaseStudies

Unit IV: Wind Energy and its assessment

Wind power scenario inIndia, Characteristics of Wind Energy: Wind movement, wind profile, roughness, effects of obstacles in wind path. wind data and site selection considerations, Comparison with Solar Energy, Types of Wind Turbine Blades, Blade Profile

Unit V: Wind Power Plants

Types of Wind Power Plants (WPPs): Small and large wind turbines; Horizontal and Vertical axis; Upwind and Downwind, One, Two and Three blades; constant and variable Speed; Geared, Direct-Drive and Semi-Geared (Hybrid) WPPs; WECS, WEGs, WTs, WPPs,
WPP Tower Types: Lattice; tubular: steel, concrete, hybrid, ladders, cables WPP substation: Switchgear, transformers, electronic components.

Unit VI: Design and Control Aspects of Wind Mill/Plant

Design: horizontal and vertical axis wind turbines, blades, control mechanisms, drive train, tower, nacelle, foundation, choice of materials, manufacture, adaptation to different climates
Control: control targets, system modelling, control strategies (pitch and stall regulation), hardware
Systems: wind power parks, transports, erection, grid connection, operation, maintenance

List of Practical:

1. Design of solar food drier for domestic purpose referring existing system.
2. Measurement of Solar Insulation at Residence.
3. Design of Solar Pump for Farm Irrigation.
4. Design of solar photovoltaic system for domestic/ commercial building purpose.
5. Design of Solar Operated home appliance.
6. Case study on designing miniature wind mill for domestic purpose referring existing system.
7. Visit to Solar PV System/wind power system used in commercial building.

Text Books:

1. S. P. Sukhatme, 'Solar Energy: Principles of thermal collections and storage', McGrawHill
2. G. D. Rai, 'Non-Conventional Energy Sources', Khanna Publisher
3. Tiwari G N. 'Solar Energy: Fundamentals, design, modeling and Applications', Narosa,2002

Reference Books :

1. MukundR.Patel,'WindAndSolarPowerSystems:Design,AnalysisandOperation,Second Edition', CRCPress
2. Kreith And Kreider, Solar Energy Handbook, McGrawHill
3. Ray Hunter, 'Wind Energy Conversion: From Theory to Practice', John Wiley and SonLtd
4. Gary L Johnson, 'Wind Energy Systems', Prentice-Hall Inc., NewJersey
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. RobertGasch,'WindPowerPlantFundamentals,Design,ConstructionAndOperations', Springer
8. C S Solanki, 'Solar Photovoltaic: Fundamentals, Technology And Applications', PHI Learning

Open Elective III
IOEUA40184A:Robotics

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

Prerequisite: NA

Course Objectives:

- To acquire basic understanding of Industrial Robots and its technological applications
- To understand peripherals of Robotic system and their use.

Course Outcomes:

Upon completion of the course, students will be able to

1. Recognize and differentiate between different types of Robots, and their features.
2. Understand industrial applications of Robots.
3. For the given industrial application students will be capable of selecting the apropriate Robot considering all the parametrs.
4. Understand different concepts related to industrial Robotics like Robot programming methods, end effecros, sensors, actuators etc.

Unit I: Fundamental of Robotics

Evolution of Robots, Types of Robots, Reason behind use of Robot, Robot Uses cases, Advantages of Robot, Disadvantages of Robot, Defining Robot, Laws of Robotics, Future of Robot,

Unit II: Performance Specifications of Industrial Robots

DOF of Robot, Joints and Links in Robot, Singularity in Robots, Industrial Applications of Robot, Selection parameters and Robot Specification.

Unit III: Insight Industrial Robot

Actuators: Pneumatic, Hydraulic and Electric, Brakes, Encoder, Transmission, Gears, Soft limits and Hard Limits.

Unit IV: System Peripherals

Controller, Teach Pendant, End Effectors, Field Sensors, Fixtures, Communication between System Peripherals, Pneumatic System, PLC, SCADA, IIOT.

Unit V: Robot Programming

Robot Programming Concepts, Programming Methods, Offline Programming, Programming Languages, Program Organization, Writing Robot Program of Instructions, Robot Simulation, Coordinate Systems

Unit VI: Social Issues Related to Robotics

Reasons for installing Robots, Economic costs and benefits of installing industrial Robots, Acceptability of industrial Robots by the workforce, Employment and Other social issues of Robotics.
Text/Reference Books :
01. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012. 02. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999. 03. Saeed B. Niku, " Introduction to Robotics – Analysis, Systems and Application" : PHI 2006 04. D J Todd, "Fundamentals Of Robot Technology" Kogan Page, 1986
Practical :
1. System Peripherals 2. Jogging in Different Modes and their Differences 3. Path Planning 4. Robot Programming

Open Elective III
IOEUA40184B:Quantum Computing

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

Prerequisites : Data Structures and Algorithms, Programming in Python / C#, Machine Learning and Data Science Basics, Neural Networks and Deep Learning Basics, Information Theory and Models of Computation, Classical Fourier Transform

Course Objectives:

- To provide introduction and necessary expertise to the learner in the upcoming discipline of Quantum Computing and Machine Learning.
- To enable the students to learn Quantum Computing and Quantum Machine Learning in practical-oriented learning sessions so that he/she can independently use existing open-source Quantum Computing Hardware and Software Frameworks.
- To teach the students to develop hybrid solutions by applying Quantum Machine Learning to potential business application areas.
- To study Quantum Information Theory and Quantum Computing Programming Model of Computation.
- To study Quantum Algorithms and apply these to develop hybrid solutions .
- To study Quantum Concepts necessary for understanding the Quantum Computing Paradigm and compare the available hardware and software infrastructure and frameworks made available open source by major players in the Industry and Academia.

Course Outcomes:

After completion of the course, student will be able to

- Explain the working of a Quantum Computing program, its architecture and programming model.
- Develop quantum logic gate circuits.
- Develop quantum algorithm(s).
- Program quantum algorithm on major toolkits.
- Develop Hybrid Solutions in Quantum Machine Learning for potential applications / use cases.
- Compare existing features provided by potential hardware and software infrastructure and frameworks service providers.

Unit I: Introduction to Quantum Computing (6 hours)

IMotivation for studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.), Origin of Quantum Computing, Overview of major concepts in Quantum Computing, Qubits

and multi-qubits states, Bra-ket notation, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement

Unit II: Mathematical Foundation of Quantum Computing (4 hours)

Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigenvectors.

Unit III: Building Blocks for Quantum Program (8 hours)

Architecture of a Quantum Computing platform, Hybrid Approach for Application Development, Details of q-bit system of information representation: Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perspective e.g. Bell State, Operation on qubits: Measuring and transforming using gates, Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc., Programming model for a Quantum Computing Program, Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits, Models of Computation used by key players as OEMs in Quantum Computing

Unit IV: Quantum Algorithms (8 hours)

Basic techniques exploited by quantum algorithms, Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks, Major Algorithms, Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm, OSS Toolkits for implementing Quantum program, IBM quantum experience, Microsoft Q#, Rigetti PyQuil (QPU/QVM) OR Cambridge Quantum Computing, Google's Tensorflow Quantum, Amazon Bracket, D-Wave Frameworks

Unit V: Machine Learning and Deep Learning (6 hours)

Machine Learning, Deep Learning and Artificial Intelligence Basics, Machine Learning Algorithms, Deep Learning Algorithms, Evolutionary Learning Algorithms

Unit VI: Quantum Machine Learning (10 hours)

Quantum Machine Learning and Quantum AI, Quantum Neural Networks, Quantum Natural Language Understanding, Quantum Cryptography, Application Domains for Quantum Machine Learning: Chemistry/Material Science, Space Tech, Finance related Optimisation Problems, Swarm Robotics, Cyber security

Text Books :

1 Quantum Machine Learning (What Quantum Computing Means to Data Mining) by Peter Wittek, University of Boras, Sweden - Elsevier Publications

2. Principles of Quantum Artificial Intelligence by Andreas Winchert, Instituto Superior Técnico - Universidade de Lisboa, Portugal - World Scientific Publishing, British Library Cataloguing-in-Publication Data

Reference Books :

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2. David McMahon, "Quantum Computing Explained", Wiley
3. IBM Quantum Experience: https://quantumexperience,ng,bluemix.net https://quantum-computing.ibm.com/docs/
4. Microsoft Quantum Development Kit https://www.microsoft.com/en-us/quantum/development-kit
5. Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/
6. Amazon Bracket Documentation on AWS: https://aws.amazon.com/braket/

7. D-Wave Systems Documentation: https://docs.dwavesys.com/docs/latest/index.html

List of Practicals/Assignments:

1. Building Quantum dice
2. Building Quantum Random Number Generator
3. Composing simple quantum circuits with q-gates and measuring the output into classical bits.
4. Implementation of Shor's Algorithms
5. Implementation of Grover's Algorithm
6. Implementation of Deutsch's Algorithm
7. Implementation of Deutsch-Jozsa's Algorithm
8. Mini Project such as implementing an API for efficient search using Grover's Algorithms or Integer factorization using Shor's Algorithm
9. Graph Partitioning using Quantum Machine Learning
10. Implementing Quantum Neural Network
11. Basics program implementing Quantum Natural Language Understanding Solution
12. Comparative study of Quantum Software Frameworks

Open Elective III
IOEUA40184C:Business Intelligence

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

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

- Describe the importance of Business Intelligence and need of data preparation for Business Intelligence.
- Identify, describe, relate to the concepts of different components of analytics landscape and project cycle aligned with these components.
- Design and develop different data transformations, data models, analyse and visualize the data.
- Designanddevelopcustomcalculationsbasedonbusinessandtechnicalneedsanddemonstrateand implement different statistical concepts.
- Author BI deployments, BI environments.
- Describe and compare industrial BI implementations, use cases and current and future trends

Unit I: Introduction to Analytics and Data Preparation (6 Hrs)

Introduction to Analytics: What is Analytics? Need of Analytics, Types of Analytics, Role of Analytics in Business

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

Power BI Desktop: Need of visualisation, Different Visualisation tools, Why Microsoft Power BI?Installation and configuration of Power BI Desktop, Setup of required connector

Data Visualization: What are KPIs?Dashboards, Reports and Scorecards, Types of Dashboards, Slicers and Filters, Setting interactivity, Drilldowns and Drill-through, Formatting your visualizations, Best practices of visualizations

Unit II: Data& BI Landscape and Project Cycle (6 Hrs)

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, Type of Data: Structured, Unstructured and Semi-structured

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

BI Project Lifecycle: Requirements Understanding, Data Understanding, Data Integration and Data warehouse, Reporting and Analysis, Dashboard development, Deployment, Documenting, Project Team and Roles, Challenges in Projects

Unit III: Data Preparation and Data Modelling (6 Hrs)

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

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

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

Data Modelling: Setting Relationships, Creating Data Models

Unit IV: Custom Calculations And Analytics (6 Hrs)

Data Transformations [Advanced]: Pivot/Unpivot data, Split data, Handling inconsistent data, Conditional Column, Custom column

Calculations: Introduction to DAX, Calculated Column, Calculated Measures, M-Query calculations, YTD, QTD, MTD calculations, Moving Averages and Running Total

Statistical Analysis: Central Tendency: Mean, Mode, Median, Dispersion: Variance and Standard Deviation, Summarization data by using histogram

Unit V: Power BI Deployment, Administration And Mobility (6 Hrs)

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

Power BI Mobile: Creating Dashboards for Mobiles, using dashboards and reports using Mobile App

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

Unit VI: Industry Analytics Landscape (6 Hrs)

Tableau Overview: Introduction to Tableau, Tableau Products, Tableau architecture, Installation and Setup of Tableau Desktop, Visualizing with Tableau, Tableau online and Tableau server, Publish and share reports on Tableau online

Applications of Business Intelligence: Manufacturing Use Cases, Retail Use Cases, Marketing use Cases, Banking 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, KoganpagePublicaitons, 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 Practicals/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

Open Elective III
IOEUA40184F: Business Analytics

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

Prerequisites:

Database Management System, MS-Excel

Course Objective(s):

6. To study and understand the importance of Business Intelligence and need of data Visualisation for Business Intelligence.
7. To study and understand the different components of analytics landscape and project cycle aligned with these components.
8. To study and understand different data transformations, data modelling steps and visualize the data on the data models.
9. To study and understand implementation and evaluation ways of adding custom calculations needed and descriptive analysis and prediction analysis by performing regression.
10. To study and understand the BI deployments, administration cycle of BI implementations using Power BI
11. 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:

Upon completion of the course, students will be able to

After completion of the course, student will be able to

7. Describe the importance of Business Intelligence and need of data visualisation for Business Intelligence.
8. Identify, describe, relate to the concepts of different components of analytics landscape and project cycle aligned with these components.
9. Design and develop different data transformations, data models, analyse and visualize the data.
10. Design and develop custom calculations based on business and descriptive analysis and prediction analysis by performing regression.
11. Author BI deployments, BI environments.
12. Describe and compare industrial BI implementations, use cases and current and future trends.

Unit I: Introduction to Analytics and Data Preparation

Introduction to Analytics: What is Analytics? Need of Analytics, Types of Analytics, Role of Analytics in Business

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

Power BI Desktop: Need of visualisation, Different Visualisation tools, Why Microsoft Power BI? Installation and configuration of Power BI Desktop, Setup of required connector

Data Visualization: What are KPIs? Dashboards, Reports and Scorecards, Types of Dashboards, Slicers and Filters, Setting interactivity, Drilldowns and Drill-through, Formatting your visualizations, Best practices of visualizations

Unit II: Data & Analytics 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, Type of Data: Structured, Unstructured and Semi-structured
BI Architecture: BI Architecture, Data Security and Governance, Administration
BI Project Lifecycle: Requirements Understanding, Data Understanding, Data Integration and Data warehouse, Reporting and Analysis, Dashboard development, Deployment, Documenting, Project Team and Roles, Challenges in Projects.

Unit III: Data Preparation and Data Modelling

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

Data Transformation [Basics]: Merging and Appending Data, Filtering, Cleaning Data, Fixing Errors, Transforming Data, Aggregating Data
Data Modelling: Setting Relationships, Creating Data Models

Unit IV: Custom Calculations And Analytics

Data Transformations [Advanced]: Pivot/Unpivot data, Split data, Handling inconsistent data, Conditional Column, Custom column
Calculations: Introduction to DAX, Calculated Column, Calculated Measures, M-Query calculations, YTD, QTD, MTD calculations, Moving Averages and Running Total
Statistical Analysis using MS-Excel: Central Tendency: Mean, Mode, Median, Dispersion: Variance and Standard Deviation, Summarization data by using histogram, Regression Model & Types, Forecasting using Excels, Interpreting Regression Result

Unit V: Power BI Deployment, Administration And Mobility
Power BI Deployment: Overview of Power BI Service, Publishing reports to Power BI Service, Understanding the Power BI Service User Interface, Creating Dashboards in Power BI Service, Subscriptions, Comments and Data Driven Alerts, authoring reports within Power BI Service, sharing dashboards across your organization, Configuring Power BI Gateway, scheduling automated refresh of your reports using Data Gateway **Power BI Mobile:** Creating Dashboards for Mobiles, using dashboards and reports using Mobile App **Power BI Advanced Features:** Using NLP to creating dashboards, Influencers, Delivering Insights, Explain Analysis
Unit VI: Industry Analytics Landscape
Tableau Overview: Introduction to Tableau, Tableau Products, Tableau architecture, Installation and Setup of Tableau Desktop, Visualizing with Tableau, Tableau online and Tableau server, Publish and share reports on Tableau online **Applications of Business Analytics:** Manufacturing Use Cases, Retail Use Cases, Marketing use Cases, Banking use cases, Future Trends of Analytics.
Term Work:
Assignments on all units
Textbooks:
5. "Business Intelligence Guidebook: From Data Integration To Analytics" by Rick Sherman, Elsevier Inc. 6. "Successful Business Intelligence, Second Edition: Unlock The Value Of BI & Big Data" by Cindi Howson, McGraw Hill Edition 7. "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 8. 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:
2. "Performance Dashboards – Measuring, Monitoring, And Managing Your Business" by Wayne Eckerson, John Wiley & Sons, Inc 3. "Business Intelligence Roadmap: The Complete Project Lifecycle For Decision-Support Applications" by Larissa T. Moss & Shaku Atre, Addison-Wesley information Technology Series 4. "Artificial Intelligence: Building Intelligent Systems" by Dr. Parag Kulkarni, Dr. Prachi Joshi, PHI publication (for understanding of concepts)

ETUA40185: Intellectual Property Rights

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

Course Objectives:

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

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

1. Understand the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
2. Identify different types of Intellectual Properties (IPs)
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: (6Hrs)

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: (6Hrs)

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: (6Hrs)

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: (6Hrs)

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

Professional Elective VI
ETUA42181A:High Performance Computing

Teaching Scheme	Examination Scheme						
Credits: 04	CIE	ISE	SCE	ESE	OR	TW	Total
Lecture (L): 03hrs./week Tutorial (T): - Practical (P): 02 hrs/week	20	30	20	30	25	--	125

Prerequisite: Students are expected to know the concepts:
1. Processor architecture in general,
2. Anyone 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: At the end of this course, students will demonstrate the ability 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 (6 HRs)
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(6 HRs)
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 (6 HRs)
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 (6 HRs)
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: (6 HRs)

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

Unit VI: Unit VI: Trends in parallel Computing (6 HRs)

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:

After completion of this course student should be able to

1. Use Parallel programing framework for application
2. Explore multi/Many core architecture

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.

Mini Project/Seminar (SCE):

A case study of HPC implementation for control/compute /communication system.

Professional Elective: VI

ETUA42181B: Computer Vision

Teaching Scheme	Examination Scheme						
Credits: 04	CIE	ISE	SCE	ESE	**OR**	TW	Total
Lecture (L): 03hrs./week Tutorial (T): - Practical (P): 02 hrs/week	20	30	20	30	25	--	125

Prerequisite: 1. Digital Image Processing
2. Linear Algebra

Course Objectives:

- To introduce students to Projections, Camera Models and Camera Calibration used for image formation. Computer Vision fundamentals , applications and challenges and complexities in Computer Vision Systems.
- To introduce students to Stereo Imaging techniques, Multi-View geometry and 3D reconstruction algorithms.
- To study the techniques and algorithms used for Object tracking in Videos.
- To introduce Object recognition techniques.
- To develop and test basic Computer Vision algorithms in Python/Tensorflow /Keras

Course Outcomes:

By the end of the course, students will able to

- Develop understanding of image formation , working of camera as image sensor and Camera Calibration
- Implement difference feature detection techniques
- Understand stereo imaging concept, its applications and challenges.
- conceptualize and understand computer vision algorithms for motion tracking
- Use neural networks and deep networks in pattern recognition.
- Develop different real time computer vision applications

Unit- I : Introduction to Computer Vision and Image Formation (6 Hrs)

Purpose, state of the art , Applications , Challenges in computer vision, CMOS CCD image sensors, Projective Geometry, Camera parameters, Camera model and Camera calibration •, Perspective, Digital camera, Bayers pattern. Smart Camera and its applications.

Unit II: Feature Detection and Matching(6 Hrs)

Points and patches, Edges, Lines, Segmentation: Active contours, Level set representations, Fourier and wavelet descriptors, Graph-Cut and energy-based methods, Texture Descriptors, Colour Features, Corner Point Detectors, Scale Invariant Feature Transform.

Unit -III:Stereo Imaging (6 Hrs)

Binocular imaging systems ,Concept, , triangulation, Correspondence , Epipolar geometry, rectification, dynamic programming . 3D reconstruction, Multi-view stereo: Volumetric and 3D surface reconstruction. Shape from silhouettes, Image registration, techniques, panorama creation

Unit -IV: Motion and Objective tracking (6 Hrs)

Basics of motion, corner detector, and optical flow by Lucas Kanade mean shift tracking, Kalman filter, Object Tracking, condensation. Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation, Structure from motion, Motion Tracking in Video

Unit V: Pattern recognition in Computer Vision (6 hrs)
Artificial Neural Network for Pattern Classification, Convolutional Neural Networks, Autoencoder, Machine Learning Algorithms and their Applications in Image Segmentation. Image fusion

Unit VI : Applications of Computer Vision**(6 Hrs)**
Thermal and Infrared Imaging. Range Imaging, In Vehicles: Lane Detection , Stereo Obstacle Detection, Laser Obstacle Detection, Vehicle Detection. Biometrics, document processing, Face and Facial Expression Recognition, Gesture Recognition

Text Books

1. Richard Szeliski, Computer vision algorithms and applications, springer
2.M.K. Bhuyan , " Computer Vision and Image Processing: Fundamentals and Applications", CRC Press 2020,

3. EmanueleTrucco, Alessandro Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998
4. Mubarak Shah, Fundamentals of Computer Vision, Online book

Reference Books :

1. Chen, Chi Hau, ed. *Handbook of pattern recognition and computer vision*. World Scientific, 2015.

2. Hornberg, Alexander, ed. *Handbook of machine and computer vision: The guide for developers and users*. John Wiley & Sons, 2017.

3. Forsyth and Ponce, Computer Vision: A Modern Approach, Prentice Hall

List of Practical (Using Python OpenCV/ MATLAB)
1) Perform the detection of edges, points and lines from the given images.
2) Perform the detection of corners from the given images.
3) Performa the camera calibration for your mobile camera and determine its intrinsic and extrinsic parameters.
4) Determination of depth estimation using stereo vision.
5) Plotting the optical flow for the given video sequence.
6) Fusion of two images of different modalities (CT/MRI , SAR/Multispectral) using PCA/ Min-Max/ Wavelet based fusion techniques.
7) Document image processing for English / Devanagari character recognition.
8) Any one application in field of computer vision and machine learning.

Professional Elective VI
ETUA42181C: Analog IC Design

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	OR	TW	Total
Lecture (L): 3 hrs./week Tutorial (T): 0 Practical (P):2 hrs/week	20	30	20	30	25	--	125

Prerequisite: Students are expected to know the concepts studied in following courses:

1. Electronic Devices and Circuits
2. Engineering Circuit Analysis

Course Objectives:

- To get acquainted with MOS transistor models and CMOS fabrication process.
- To analyze and design single-stage and differential amplifiers.
- To realize and understand the need of current mirrors and biasing techniques for analog CMOS circuits.
- To analyze and design different types of operational amplifiers.
- To study different types of bandgap reference circuits.

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

7. Be well versed with the MOS transistor models and CMOS fabrication process.
8. Analyze and design single-stage amplifiers.
9. Analyze and design differential amplifiers.
10. Understand current mirrors and biasing circuits and it's usage in designing amplifiers.
11. Analyze and design operational amplifiers for a given specifications.
12. Cognize different bandgap reference circuits and its applications.

Unit I: MOS Transistor Models and Overview of CMOS Technology (6 Hours)

MOS device capacitances, MOS small-signal model, MOS SPICE models, Fabrication process flow, Wafer processing, Photolithography, Oxidation, Ion implantation, Deposition and Etching.

Unit II: Single-Stage Amplifiers (6 Hours)

Common-source stage with different type of loads, Source follower, Common-gate stage, Cascode and folded-cascode stage. Frequency response of CS, CD (source follower), CG, and cascode amplifiers.

Unit III: Differential Amplifiers (6 Hours)

Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads, Gilbert cell. Frequency response of differential pair with passive and active loads.

Unit IV : Current Mirrors and Biasing Techniques (6 Hours)

Basic and cascode current mirrors, Active current mirrors, Large-signal and small-signal analysis, Biasing techniques: CS biasing, CG biasing, Source follower biasing, and Differential pair biasing.

Unit V: Operational Amplifiers (6 Hours)

One-stage op amps, Telescopic and folded-cascode op amps, Two-stage op amps, Gain boosting, Common-mode feedback, High slew rate op amps, and power supply rejection.

Unit VI: Bandgap References **(6 Hours)**

Supply independent biasing, Temperature-independent references, PTAT current generation, Constant-Gm biasing, Low-voltage bandgap references.

Text Book :

1.BehzadRazavi, "Design of Analog CMOS Integrated Circuits," 2nd Edition, McGraw Hill.

Reference Books :

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits," 5th Edition, Wiley.
2. Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design," 2nd Edition, Oxford University Press.

List of Experiments:

After completion of this course student should be able to

1. do SPICE modeling of digital circuits using modern tools.
2. prepare layout of digital CMOS circuits and verify the functionality using modern tools.

(A) To do SPICE modeling of following circuits at selected technology node.

5. Current mirror
6. Single-stage CS amplifier
7. Differential amplifier
8. Two-stage op amp.

(B) To prepare CMOS layout in selected technology, simulate with and without capacitive load.

1. Current mirror
2. Single-stage CS amplifier
3. Differential amplifier
4. Two-stage op amp.

Mini Project/Seminar (SCE)

Professional Elective VI
ETUA42181D: Artificial Intelligence

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

Prerequisite: Students are expected to know the concepts studied in following courses:
1. Fundamentals of computer programming
2. Data structure

Course Objectives:
- .To understand the various characteristics of Intelligent agents.
- To learn the different search strategies in AI.
- To learn how to represent knowledge in solving AI problems.
- To introduce the concepts of learning
- To know about the various applications of AI.

Course Outcomes: At the end of this course, students will demonstrate the ability to
1. Explain different types of AI Agents and environment. (Understand)
2. Implement AI search algorithms.(Apply)
3. Solve fundamental problems using First Order Logic (Apply)
4. Understand Outline different planning strategies (Understand)
5. Implement supervised learning algorithms (Apply)
6. Understand different AI application (Understand)

Unit- I: Introduction (6 Hrs)
Introduction to Artificial Intelligence (AI), History and Future of AI, Intelligent Agent - Agent and Environment, Rationality, The nature of Environment, Problem Solving by Searching-State Space Search.

Unit- II: Problem Solving Search(8 Hrs)
Problem Solving by Searching- Uninformed Search, Informed Search-A* Search-Heuristics-Local Search Algorithms and Optimization-Hill Climbing, , Constraint Satisfaction Problem,(CSP)- Backtracking search for CSP, Games- Single Agent Games, Two-Agent Games-Optimal Decisions in Games-Min-Max Algorithm, Alpha Beta Pruning, Stochastic Games

Unit –III: Knowledge Representation and Logic(6 Hrs)
Knowledge representation using Propositional logic, Knowledge Representation using First Order Logic(FOL), Reasoning using FOL, Resolution using FOL, Use of predicate calculus, Rule Based System

Unit IV : Planning(6 Hrs)
Planning and acting in real world- Hierarchical Task Network Planning, Planning and Acting in Non-deterministic Domain, Conditional Planning-Fully Observable Environment, Partially Observable Environment, Executing, Monitoring and Re-planning, Continuous Planning, Multi Agent Planning

Unit V: Learning(6 Hrs)
Introduction to Learning, Machine Learning, Different Types of Learning, Hypothesis, Choosing the Best Hypothesis, Rule Induction and Decision Tree, Training Error and Test Set Error, Over fitting the data, Training and Validation. Learning Using Neural Network, Perception, Gradient Descent, Multi Layer

Network, Activation Functions, Applications of Neural Network. Probabilistic Learning-Bayesian Learning

Unit VI: AI Applications(4Hrs)

AI applications – Language Models – Information Retrieval- Information Extraction –Natural Language Processing - Machine Translation – Speech Recognition – AI in Robotics – Robot Hardware, Robotic Perception, Planning, Moving

Text Books :

1 S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009.
2 Kevin Night and Elaine Rich, Nair B., ―Artificial Intelligence (SIE),McGrawHill-2008.
3 Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998

Reference Books :

1 Peter Jackson, ―Introduction to Expert Systems, 3rd Edition, Pearson Education, 2007.
2 DeepakKhemani ―Artificial Intelligence, Tata McGraw HillEducation 2013.
3 Dan W. Patterson, ―Introduction to AI and ES‖, Pearson Education, 2007

List of Experiments:

After completion of this course student should be able to

1. Implement A* approach for any suitable application.
2. Assignment on Constraint Satisfaction Problem: Implement graph coloring problem.
3. Implementation of Min-Max Algorithm
4. Implement goal stack planning for the blocks world Problem
5. Implement Naive Bayes algorithm for sample data
6. Implementation of decision tree for sample data
7. Implementation of Multilayer Perceptron Neural Network for sample data
8. Write a program to correct the spelling of English paragraph.(NLP Based).

Mini Project/Seminar (SCE) Mini project

Open Elective IV
IOEUA42182A :Engineering Economics

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

Prerequisite: Students are expected to know the concepts studied in following courses:
1.Basic Maths

Course Objectives:
- To learn the basics of economics and cost analysis relevant to engineering
- To identify conditions for present worth comparison and future worth comparison and find appropriate solutions for the information challenges.
- To learn and calculate the Rate of interest, different costs and overheads ,profit and loss accounts

Course Outcomes: At the end of this course, students will demonstrate the ability to
1.Understand the economics and cost analysis
2.Compare present worth and future worth
3.Identify rate of return and different taxes
4.Calculate profit and loss

Unit- I: Introduction (6 Hrs)
Engineering and Economics, Law of demand and supply, Theory of the Firm and Market Structure. Basic Macro-economic Concepts (including GDP/GNP/NI/Disposable Income), Law of returns, Interest and Interest factors: Interest rate, Simple interest, Compound interest, Cash - flow diagrams, Personal loans and EMI Payment. Price Indices(WPI/CPI),

Unit- II: Present-Worth and Annual Worth Comparisons(6 Hrs)
Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Present worth, Future-worth comparison, Pay-back comparison, Exercises, Discussions and problems. Equivalent Annual-Worth Comparison methods, Situations for Equivalent Annual-Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Use of shrinking fund method.

Unit –III: Rate-Of-Return And Depreciation(6 Hrs)
Rate of return, Minimum acceptable rate of return, Investment Analysis – NPV, ROI, IRR, Payback Period, Time value of money, Components of costs such as Direct Material Costs, Direct Labor Costs Causes of Depreciation, Basic methods of computing depreciation charges, Tax concepts, corporate income tax.

Unit IV: Finance and Banking(6 Hrs)
Statements of Financial Information: Introduction, Source of financial information, Financial statements, Balance sheet, and Profit and Loss account, relation between Balance sheet and Profit and Loss

account.Financial Institutions, Finance Commissions, BudgetAnalysis. Indian Banking, Role of Reserve bank of India International Economy

Text Books :

1 Leland T. Blank and Anthony J. Tarquin , "Engineering Economy" 4th Edition ,McGraw Hill Publication .
2 Chan S. Park "Contemporary Engineering Economics", 3rd Edition,PHI Publications.
3 Dr.K.K.Dewett and M. H. Navalur ," Modern Economic Theory"RevisedEdition,S Chand Publication.

Reference Books :

1.V. Mote, S. Paul, G. Gupta(2004), Managerial Economics, Tata McGraw Hill
2. Misra, S.K. and Puri (2009), Indian Economy, Himalaya

List of Tutorials:

1. Study of cash flow diagram and interest rates
2. Study of Present worth Comparison
3. Study of Annual worth Comparison
4. Study of Investment Analysis
5.Study of Financial statements and Balance sheet

Open Elective V

IOEUA42183B:Inferential Statistics for Data Science

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./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. 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 fundamentalsof probability distributions and their application for data analysis
- To derive the conclusions from the data sets with Bayesian and Inferential statistics

Course Outcomes:

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 (6 HRs)

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(6 HRs)

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 (6 HRs)

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(6 HRs)

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**, SantiRanjan, **Das**, Ajit Kumar, "Estimation and Inferential Statistics", Springer

2 S.C. Gupta and V. K. Kapoor : Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 88, Daryaganj, New Delhi, 2.

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

Practicals: Practicals can be done 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

ETUA42184: Introduction to Research

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 1 hrs./week Tutorial (T): - Practical (P): 2 hrs/week	-	-	-	-	-	25	25

Prerequisite: Basic statistical tools

Course Objectives:
- To introduce to the concept of research and research problem
- To understand research ethics
- Get introduced to the concept of Intellectual property rights.
- To understand developments in IPR.

Course Outcomes: Upon learning the course the student will be able to
1. Define research and formulate a research problem.
2. Discuss the importance of Research Design and Literature Review.
3. Discuss classification of data and preliminary data analysis.
4. Write a research proposal to a suitable funding agency.

Unit I : Introduction to Research and Research problem
Meaning of research, types of research, process of research, Objectives of research, Research and Scientific Method, Sources of research problem, Criteria / Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, defining a research problem (Real life example or case study), formulation of research hypotheses, Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance

Unit II : Research Design and Literature review
Research Design- Concept and Importance in Research, different research designs in research studies, Literature survey- Definition of literature and literature survey, need of literature survey, elements and objectives of literature survey, sources of literature-monographs-patents – web as a source, Critical literature review – Identifying gap areas from literature review and strategies of literature survey, Errors in research

Unit III : Data and Data Analysis
Classification of data, benefits and drawbacks of data, qualitative methods of data collection, types of data analysis, Sampling, sample size, sample design, Testing of hypothesis and Goodness of Fit: Definition of null and alternative hypothesis, student's 't' distribution, Chi-square distribution, F-test, analysis of variance techniques, introduction to non-parametric tests. Regression Analysis – Simple Linear Regression, Multiple linear Regression

Unit IV : Report, Research proposal and funding agencies
Need of effective documentation, types of reports and their format. Essentials of a research proposal. Different funding agencies for research. Research briefing, presentation styles, elements of effective presentation, writing of research paper, presenting and publishing paper, patent procedure, ethical issues

Text Books: 1. Dr. C. R. Kothari, "Research Methodology: Methods and Trends," New Age International Publishers. 2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction." 3. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners."
Reference Books: 1. Deepak Chawla and NeenaSondhi, "Research Methodology: concepts and cases," Vikas Publishing House Pvt. Ltd. (ISBN 978-81-259-5205-3) 2. Louis Cohen, Manion, Morrison, "Research Methods in Education," Routledge (Taylor & Francis Group) /Cambridge University Press India Pvt. Ltd., ISBN-978-0-415-58336-7 3. Sekaran Uma and Roger Bougie, "Research Methods for Business," Wiley, India.