



Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Structure and Syllabus of B.Tech.

Electronics and Telecommunication Engineering

Effective from Academic Year 2025-26

Prepared by: - Board of Studies in Electronics and Telecommunication Approved by: - Academic Board,
Vishwakarma Institute of Technology, Pune

Chairman – BOS

Chairman – Academic Board





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Institute Vision

“To be a globally acclaimed institute in technical education and research for holistic socio-economic development.”

Institute Mission

- To ensure that 100% students are employable and employed in Industry, Higher Studies, become Entrepreneurs, Civil / Defense Services / Govt. Jobs and other areas like Sports and Theatre.
- To strengthen Academic Practices in terms of Curriculum, Pedagogy, Assessment and Faculty Competence.
- Promote Research Culture among Students and Faculty through Projects and Consultancy.
- To make students Socially Responsible Citizen.

Department Vision

“To be a centre of academic excellence in Electronics, Telecommunication and related domains through continuous learning and innovation.”

Department Mission

- To provide state of art education in Electronics and Telecommunication Engineering to meet current and future needs of society, industry, and academia.
- To strengthen collaborations with industries and institutes of repute to foster research culture among faculty members and students.
- To promote ethically conscious engineers demonstrating sustainable entrepreneurship and professional maturity in a social context.

Program Educational Objectives (PEOs)

Graduates of the program will

1. Have a comprehensive knowledge of Electronics engineering fundamentals to face the challenges of real-life complex problems.
2. Be professionals imbued with a spirit of leadership, ethical behavior, and societal commitment.
3. Be compliant to constantly evolving technology through lifelong learning.

Program Specific Objectives (PSOs)

E&TC Graduates will have the ability to:

1. Design, develop and analyze complex Electronic Systems for communication, Signal Processing, Embedded Systems, and VLSI applications.
2. Identify and apply domain-specific hardware and software tools to solve real-world problems in Electronics and Communication.

Program Outcomes (POs)

Engineering Graduate will be able to

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 the 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 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 teamwork:** 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 of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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.

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Title: Course Structure-C25, Module: V**FF No. 653****Branch: E&TC****Year: T.Y.****A.Y.: 2025-26****Module: V, Sem1**

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)				Assessment Scheme (100-mark scale)									Credits		
			Theory	Lab	Tut		IS A						ESA			Total		
							HA	LB	CP	PPT	GD	MSE	ESE	Lab	CVV			
S1	ET3002	Digital Signal Processing	2	2	1		10	20		20		30		20	100	4		
S2	ET3221	Computer Vision	2	2	1		10	20					50	20	100	4		
S3	ET3206	Digital Design	2	2	1		10	20	20			30		20	100	4		
S4	ET3271	Embedded System Design	2	2	1		10	20		20		30		20	100	4		
S5	ET3279	Engineering Design and Innovation – V	0	12	0	-	-	-	-	-	30	70		-	100	6		
S6	ET3282	Design Thinking 5			1											1		
S7	SH3001	Reasoning And Aptitude Development	1														1	
		Total	9	20	5											24		

Title: Course Structure C25, Module: VI**FF No. 653****Branch: E&TC****Year: T.Y.****A.Y.: 2025-26****Module: VI, Sem1**

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)		Assessment Scheme (100-mark scale)										Credits	
			Theory	Lab	Tut	ISA					ESA			Total		
						HA	LB	CP	PPT	GD	MSE	ESE	Prac. Exam	CVV		
S1	ET3002	Digital Signal Processing	2	2	1		10	20		20		30		20	100	4
S2	ET3272	Design and Analysis of Algorithms	2	2	1		10	20					50	20	100	4
	ET3265	Control Systems	2	2	1		10	20	20			30		20	100	4
S3	ET3274	Operating Systems	2	2	1		10	20	20			30		20	100	4
	ET3277	Digital Communication	2	2	1		10	20	20			30		20	100	4
S4	ET3285	Computer Network Security	2	2	1		10	20		20		30		20	100	4
	ET3203	Power Electronics And Drives	2	2	1		10	20	20			30		20	100	4
S5	ET3282	Design Thinking 5			1											1

S6	ET3279	Engineering Design and Innovation – V	0	12	0	-	-	-	-	-	30	70	-		100	6
S7	SH3001	Reasoning And Aptitude Development- I	1													1
		Total	9	20	5											24

Title: Course Structure-C25, Module: V

FF No. 653

Branch: E&TC

Year: T.Y.

A.Y.: 2025-26

Module: V, Sem2

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)				Assessment Scheme (100-mark scale)								Credits		
			Theory	Lab	Tut		IS A					ESA			Total		
							HA	LB	CP	PPT	GD	MSE	ESE	Lab	CVV		
S1		Coursera Course Elective													Grade	4	
S2	ET3221	Computer Vision	2	2	1		10	20						50	20	100	4
S3	ET3206	Digital Design	2	2	1		10	20	20				30		20	100	4
S4	ET3271	Embedded System Design	2	2	1		10	20		20			30		20	100	4
S5	ET3279	Engineering Design and Innovation – V	0	12	0	-	-	-	-	-	30	70		-	100	6	
S6	ET3282	Design Thinking 5			1											1	
S7	SH3001	Reasoning And Aptitude Development	1													1	
		Total	9	20	5											24	

Title: Course Structure C25, Module: VI**FF No. 653****Branch: E&TC****Year: T.Y.****A.Y.: 2025-26****Module: VI, Sem2**

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)		Assessment Scheme (100-mark scale)										Credits	
			Theory	Lab	Tut	ISA					ESA			Total		
						HA	LB	CP	PPT	GD	MSE	ESE	Prac. Exam	CVV		
S1		Coursera Course Elective													4	
S2	ET3272	Design and Analysis of Algorithms	2	2	1		10	20					50	20	100	4
	ET3265	Control Systems	2	2	1		10	20	20			30		20	100	4
S3	ET3274	Operating Systems	2	2	1		10	20	20			30		20	100	4
	ET3277	Digital Communication	2	2	1		10	20	20			30		20	100	4
S4	ET3285	Computer Network Security	2	2	1		10	20		20		30		20	100	4
	ET3203	Power Electronics And Drives	2	2	1		10	20	20			30		20	100	4
S5	ET3282	Design Thinking 5			1											1

S6	ET3279	Engineering Design and Innovation – V	0	12	0	-	-	-	-	-	30	70	-		100	6
S7	SH3001	Reasoning And Aptitude Development- I	1													1
		Total	9	20	5											24

List of Coursera Courses

Sr.No.	Course [Code:Name:Year]
1	MD3001:HUMAN MACHINE INTERACTION:Third Year
2	MD3101:IBM Full Stack Software Developer:Third Year
3	MD3102:Meta Back-End Developer:Third Year
4	MD3103:IBM Back-End Developer:Third Year
5	MD3106:Microsoft Power BI Data Analyst:Third Year
6	MD3110:IBM Cybersecurity Analyst:Third Year
7	MD3111:Microsoft Cybersecurity Analyst:Third Year
8	MD3112:Google Cybersecurity:Third Year
9	MD3113:Google Data Analytics:Third Year
10	MD3114:IBM Data Analyst:Third Year
11	MD3115:IBM Data Analytics with Excel and R:Third Year
12	MD3116:IBM Data Engineering:Third Year
13	MD3117:Meta Database Engineer:Third Year
14	MD3118:IBM Data Science:Third Year
15	MD3119:Fractal Data Science:Third Year
16	MD3120:IBM Data Warehouse Engineer:Third Year

17	MD3121:IBM DevOps and Software Engineering:Third Year
18	MD3122:Google Digital Marketing and E-Commerce:Third Year
19	MD3123:Meta Front-End Developer:Third Year
20	MD3124:IBM Front-End Developer:Third Year
21	MD3126:Meta iOS/Android Developer:Third Year
22	MD3127:IBM IT Project Manager:Third Year
23	MD3128:Google IT Support:Third Year
24	MD3130:IBM Mainframe Developer:Third Year
25	MD3131:Meta Marketing Analytics:Third Year
26	MD3132:Akamai Network Engineering:Third Year
27	MD3133:Google Project Management:Third Year
28	MD3135:Salesforce Sales Development Representative:Third Year
29	MD3140:SAP Technology Consultant:Third Year
30	MD3141:AWS Cloud Technology Consultant:Third Year
31	MD3142:Google UX Design:Third Year
32	MD3146:MAINFRAME TECHNOLOGIES:Third Year
33	SH3002:REASONING AND APTITUDE DEVELOPMENT - 2:Third Year
34	MD3147:DEEP LEARNING.AI DEEP LEARNING:Third Year
35	MD3148:Tableau Business Intelligence Analyst:Third Year

Title: Course Structure D 25, Module: VII**Branch: E&TC****Year: B.Tech.****A.Y.: 2025-26****Module: Sem VII, sem1**

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)			Assessment Scheme (100-mark scale)									Credits
			Theory	Lab	Tut	ISA					ESA		Total		
			HA	LB	CP	PPT	GD	MSE	ESE	CVV	100				
OE 1	Bucket 1	Linkedin Learning Courses													2
	Bucket 2	Linkedin Learning Courses													2
OE2	ET4230	Natural Language Processing	2	0	0	10	-	-	-	-	30	30	30	100	2
	ET4232	Deep Learning	2	0	0	10	-	-	-	-	30	30	30	100	2
OE3	ET4430	VLSI Design Flow: RTL to GDS	1	0	0	10					30	20	20	100	2
	ET4292	Modern Digital Communication Techniques	1	0	0	10					30	20	20	100	2
S4	ET4431	Design Thinking - 7			1										1
S5	ET4207	Major Project	0	20	0	-	-	-	-	-	30	70	-	-	9

Bucket 1	Bucket 2
<p>MD4274-Large Language Models Skill Development</p> <p>MD4275-Mastering Microsoft Power BI</p> <p>MD4276-Generative AI Skills for Developers</p> <p>MD4277-Career in Data Analysis</p> <p>MD4278-Concepts of Data Visualization and Storytelling</p> <p>MD4279-AWS Certified Solutions Architect</p> <p>MD4280- IT Security Specialist</p> <p>MD4281-Technical Program Management</p>	<p>MD4282-Natural Language Processing Skill Development</p> <p>MD4283-Prompt Engineering Skills</p> <p>MD4284-Essentials in Generative AI</p> <p>MD4285-Python in Finance</p> <p>MD4286-Understanding Quantum Computing</p> <p>MD4287-Foundational Maths for Machine Learning</p>

Title: Course Structure D 25, Module: VIII**Branch: E&TC Year: B.Tech. A.Y.: 2025-26****Module: VIII, Sem1**

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)			Assessment Scheme (100-mark scale)									Credits
			Theory	Lab	Tut	ISA					ESA		Total		
			HA	LB	CP	PPT	GD	MSE	ESE	CVV	100				
S1	ET4222	Research Internship	-	40	-	-	-	-	-	-	30	100	-	100	15
	ET4250	Project Internship	-	40	-	-	-	-	-	-	30	100	-	100	15
	ET4251	Industry Internship	-	40	-	-	-	-	-	-	30	100	-	100	15
	ET4252	International Internship	-	40	-	-	-	-	-	-	30	100	-	100	15
S2	ET4431	Design Thinking - 7			1										1
		Total	-	40	-	-	-	-	-	-	30	100	-	100	16

A*: Second Semester Courses

Title: Title: Course Structure D 25, Module: VII

Branch: E&TC

Year: B.Tech.

A.Y.: 2025-26

Module: Sem VII, sem2

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)			Assessment Scheme (100-mark scale)									Credits
			Theory	Lab	Tut	ISA					ESA			Total	
HA	LB	CP	PPT	GD	MSE	ESE	CVV	100							
OE 1	Bucket 1	Linkedin Learning Courses													2
	Bucket 2	Linkedin Learning Courses													2
OE2	ET4230	Natural Language Processing	2	0	0	10	-	-	-	-	30	30	30	100	2
	ET4232	Deep Learning	2	0	0	10	-	-	-	-	30	30	30	100	2
OE3	ET443 2	Digital IC Design	1	0	0	10					30	20	20	100	2
	ET420 6	Digital Communication using GNU Radio	1	0	0	10					30	20	20	100	2
S5	ET4208	Major Project	0	20	0	-	-	-	-	-	30	70	-	-	10

Bucket 1	Bucket 2
MD4274-Large Language Models Skill Development MD4275-Mastering Microsoft Power BI MD4276-Generative AI Skills for Developers MD4277-Career in Data Analysis MD4278-Concepts of Data Visualization and Storytelling MD4279-AWS Certified Solutions Architect MD4280- IT Security Specialist MD4281-Technical Program Management	MD4282-Natural Language Processing Skill Development MD4283-Prompt Engineering Skills MD4284-Essentials in Generative AI MD4285-Python in Finance MD4286-Understanding Quantum Computing MD4287-Foundational Maths for Machine Learning

Title: Course Structure D 25, Module: VIII**Branch: E&TC Year: B.Tech. A.Y.: 2025-26****Module: VIII, Sem 2**

Subject Head	Course Code	Course Name	Teaching Scheme (Hrs/Week)			Assessment Scheme (100-mark scale)									Credits
			Theory	Lab	Tut	ISA					ESA		Total		
			HA	LB	CP	PPT	GD	MSE	ESE	CVV	100				
S1	ET4403	Research Internship	-	40	-	-	-	-	-	-	30	100	-	100	16
	ET4404	Project Internship	-	40	-	-	-	-	-	-	30	100	-	100	16
	ET4401	Industry Internship	-	40	-	-	-	-	-	-	30	100	-	100	16
	ET4402	International Internship	-	40	-	-	-	-	-	-	30	100	-	100	16
		Total	-	40	-	-	-	-	-	-	30	100	-	100	16



Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Syllabus of Third Year B.Tech.

Electronics & Telecommunication Engineering

“Pattern – C25”
Module - V

ET3002: DIGITAL SIGNAL PROCESSING

Course Prerequisites:

Exposure to algebra, complex numbers and calculus

Course Objectives:

1. To develop a thorough understanding of the signal processing systems
2. Use Discrete time Fourier series and Fourier transform to analyze Discrete time systems
3. Use z-transform and discrete Fourier transform to analyze digital systems
4. Apply DFT-FFT algorithm to perform spectral analysis of discrete time signals
5. Provide an understanding of different methods to design digital filters
6. To develop an ability to apply the DSP concepts to a wide range of real-world signal processing applications

Credits: 4

Teaching Scheme:

Theory: 2 Hours / Week

Lab/ Project: 2 Hours / Week

Tutorial : 1 Hours / Week

Course Relevance:

Signal processing is the heart of the digital revolution that brought us CDs, DVDs, MP3 players, mobile phones and countless other devices which has enabled unprecedented levels of interpersonal communication and of on-demand entertainment. The inherent flexibility of digital elements permits the utilization of a variety of sophisticated signal processing techniques which had previously been impractical to implement. A thorough understanding of signal processing fundamentals and techniques is essential for anyone whose work is concerned with signal processing applications. Signal Processing begins with a discussion of representation and analysis of discrete-time signals and systems, convolution, Fourier series , Fourier transform , DFT, FFT , Z-transform to analyze CT and DT signals and systems. Signal Processing concludes with digital filter design techniques and their efficient realizations. An integral part of the course is MATLAB based computer assignments and course projects, which are designed to reinforce theoretical concepts.

SECTION-1

Unit 1 : Discrete-time signals and systems , Discrete-time systems properties : Linearity, Time variance and causality , analysis of discrete-time LTI systems: impulse response , convolution

Unit 2: Representation of periodic signals-Discrete-Time Fourier Series, Representation of aperiodic signals Discrete-Time Fourier Transform, Properties of DTFT, Applications of Fourier series Transforms

Unit 3: Discrete Fourier Transform and its properties , Fast Fourier Transform – Decimation in Time DIT FFT, Decimation in Frequency- DIF FFT algorithms, Signal flow Graphs

SECTION-2

Unit 4: Sampling theorem , Z transform , Rational Z-transform, System function ,Inverse Z-transform , causality and stability considerations for LTI systems

Unit 5: Design and implementation of FIR filter, Linear phase FIR filter, FIR filter design using Windows method, Realization of FIR filter – Transverse structure, Linear phase structure, Hardware implementation of FIR Filters

Unit 6: Design and implementation of IIR filter Analog lowpass Butterworth filter, Design of IIR filters from analog filters –Bilinear transformation , Realization of digital filters – Direct form I, Direct form II, cascade form, Hardware implementation of IIR Filters

List of Tutorials:

1. Discrete time convolution of signals
2. Verification of sampling theorem, conversion of continuous time (CT) signals into discrete time (DT) signals and recovery of CT signals.
3. Discrete time Fourier series computation
4. Compute Z transform and inverse Z transform of DT signals
5. Analysis of LTI systems using pole-zero plot
6. Compute DFT and IDFT using direct computation and matrix method
7. Compute DFT and IDFT using FFT algorithm
8. Find, visualize, and analyze spectrum of a DT signal
9. Design IIR filters using Impulse invariance method
10. Design IIR filters using BLT method
11. Design of FIR filters using windowing method Realization of digital filters

List of Practicals:

1. To perform convolution of two discrete-time sequences in time domain.
2. To reconstruct the given periodic signal using fourier series .
3. Implement algorithm to perform linear convolution of two sequence using DFT.
4. To determine z-transform from the given transfer function and its ROC
5. Implement different window functions and observe the effect of different windows on FIR filter response
6. Design Butterworth filter (IIR) using bilinear transformation method and plot its frequency response.
7. Design and apply moving average and difference filters on the audio signals
8. Design and apply a suitable digital filter to clean noisy ECG signal

List of Projects:

1. ECG Signal Analysis Perform discrete time signal analysis using FFT.
2. Speech Enhancement using Spectral Subtraction Method.
3. Musical Instrument Identification.
4. Audio Equalizer.
5. Speech Recognition.
6. DTMF Encoder and Decoder.
7. Correcting the geometrical orientation of text in an image using discrete Fourier transform.
8. Real time filtering using overlap-save or overlap-add method.
9. Audio Effects Generation.
10. Voice Activity Detector.
11. Vibration signal analysis using signal processing techniques.
12. Design of 2D filters suitable for the given vision application.

List of Seminar Topics:

1. Use of DSP in Telephony applications
2. DSP in motor control
3. DSP in Biomedical applications – ECG,EEG MRI etc
4. DSP in Seismology
5. DSP in speech processing
6. DSP In video signal processing
7. DSP in audio signal processing
8. Multirate signal processing
9. Transforms used in DSP for various purposes.
10. DSP in processing signals coming from outer space (Pulsars, Quasars etc)
11. Issues in using DSP in Real Time applications
12. DSP in automobiles, aircrafts , marine applications etc

List of Group Discussion Topics:

1. Analog filters Vs Digital filters --- Design (typical cases) and analysis
2. Analog filters Vs Digital filters --- Implementation
3. IIR filters Vs. FIR filters -- Design (typical cases) and analysis
4. IIR filters Vs. FIR filters -- Implementation
5. Hardware Vs. Software implementation of Digital filters
6. Implementation of Digital filters on Microcontrollers, dedicated DSP Processors and FPGAs
7. uses of different transforms in DSP
8. sampling rates
9. comparison of different windows in design of FIR filter

List of Home Assignments:**Design:**

1. Design and develop a high-quality surround sound system and implement in MATLAB Simulink
2. Real Time Filtering of audio signals in MATLAB
3. Design of Adaptive noise cancellation system
4. of digital Dolby system
5. Design and implement LPC vocoder

Case Study: Design

1. FFT spectrum analyzer
2. ECG/EEG monitoring system
3. Audio compression (mp3)
4. Adaptive echo cancellation systems
5. Speech coding and decoding

Blog

1. Audio codec
2. Comb Filter implementation
3. Power spectral density estimation
4. Text-to speech synthesizer
5. Radar signal processing

Surveys

1. Selection of digital signal processor based on the application
2. Signal processing in military applications
3. Underwater signal processing
4. Hearing aids and background noise
5. Voice assistant systems (e.g. Alexa, Siri)

Assessment Scheme:

Course Project - 20 Marks
Home Assignment - 20 Marks
Presentation /Group Discussion - 20 Marks
End Semester Examination - 20 Marks
Comprehensive Viva Voce - 20 Marks

Text Books:

1. Oppenheim, Wilsky, Nawab, "Signal and systems", PHI; 2nd edition, 1996
2. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing-Principles algorithms and applications", PHI 1997
3. E.C. Ifeachor and B.W. Jervise, "Digital signal processing – A practical approach," Pearson Edu, 2nd edition, 2002
4. Oppenheim and Schafer, "Discrete-Time Signal Processing", Pearson Education India; 3rd edition, 2014

Reference Books:

1. Ramesh Babu, R. Anand Rajan, "Signal and systems", Scitech publications, 2011
2. Ramesh Babu, "Digital Signal processing," Scitech publications, 2001
3. Shalivahan, Vallavraj, Gnyanapriya C., "Digital Signal processing," TMH 2001
4. Li Tan, Jean Jiang, "Digital Signal Processing: Fundamentals and applications," Academic press.
5. S.K. Mitra, "Digital Signal Processing- A Computer Based approach," Tata McGraw Hill, 1998.

Moocs Links and additional reading material:www.nptelvideos.in<https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/>https://swayam.gov.in/nd1_noc19_ee50/preview<http://www.ws.binghamton.edu/fowler/fowler%20personal%20page/EE521.htm><http://vlabs.iitkgp.ernet.in/dsp/><https://ocw.tudelft.nl/courses/digital-signal-processing/subjects/3-ofdm/>**Course Outcomes:**

The student will be able to –

1. Analyse LTI systems in time domain
2. Analyse signals using fourier series and fourier transform
3. Apply DFT to analyse discrete time systems
4. Analyse LTI systems using Z-Transform
5. Design linear phase FIR filter of given specifications
6. Design IIR filter of given specifications from Analog filter.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	2	0	0	0	1	0	0	1	2	1
2	3	3	2	2	3	0	0	0	1	0	0	1	2	2
3	3	3	2	2	3	0	0	0	1	0	0	1	2	2
4	3	3	2	2	3	0	0	0	1	0	0	1	2	2
5	3	3	2	2	3	0	0	0	1	0	0	1	2	3
6	3	3	2	2	3	0	0	0	1	0	0	1	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Future Courses Mapping:

Courses that can be taken after completion of this course:

1. Advanced Digital Signal Processing
2. Adaptive Signal Processing
3. Speech Processing
4. Digital Image Processing
5. Audio and video data compression
6. Pattern recognition
7. Digital communication systems

Job Mapping:

Job opportunities that one can get after learning this course

Unlike in most fields of study, in digital signal processing, future jobs are not defined by or restricted to a single professional area. Signal processing – the enabling technology for the generation, transformation, extraction and interpretation of information via electronic signals – is essential for our smartphones and wearable devices, as well as the latest health care technologies, digital cameras and our digital assistants like Amazon Echo and Google Home.

ET3221: COMPUTER VISION

Course Prerequisites:

1. Linear Algebra
2. Python / C Programming
3. Basics of Digital Electronics

Course Objectives:

1. Learn Fundamentals of Digital Image Processing
2. Understand Features, their Selection and Extraction
3. Implement Object Detection
4. Implement Object Recognition
5. Implement Object Classification

Credits:4

Teaching Scheme Theory: 2 Hours/Week

Tut: 1 Hour/Week

Lab: 2 Hours/Week

Course Relevance:

Computer vision is an interdisciplinary scientific field that deals with how computers can gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to understand and automate tasks that the human visual system can do.

SECTION-1

Fundamentals of Image Formation, Human Vision System, Computer Vision System, Geometric Transformation, Fourier Transform, Discrete Fourier Transform, Convolution and Filtering, Image Enhancement, Histogram Processing, Image Registration, Image Restoration. Image Segmentation: Edge Based approaches to segmentation, Gradient using Masks, Laplacian of Gaussian, Canny, Edge Linking, Line detectors (Hough Transform), Corners – Harris, Region Growing, Region Splitting.

SECTION-2

Feature Detectors and Descriptors: Features from Accelerated Segment Test, Oriented Fast and Rotated Brief, Scale Invariant Feature Transform, Haar-Cascade, Local Binary Pattern, Local Directional Pattern, Feature Matching and Feature Tracking. Supervised and Unsupervised Machine Learning for Image Classification: Support Vector Machine, K-Nearest Neighbours, Principal Component Analysis, K-Means. Camera Geometry Fundamentals, Camera Calibration, Epipolar Geometry, Stereo Vision: Distortion, Rectification, Point-Correspondence, Triangulation.

List of Tutorials:

1. Introduction to OpenCV and Setting up Python Programming Environment for Computer Vision
2. Essentials of Linear Algebra Part-I (Matrix Theory) for Computer Vision
3. Essentials of Linear Algebra Part-II (Vector Spaces) for Computer Vision
4. Configuration of Raspberry Pi-4B for Computer Vision
5. Essentials of Raspbian Operating System
6. Configuration of Jetson Nano for Computer Vision
7. Essentials of Ubuntu Operating System
8. Camera Calibration
9. Mathematics of Support Vector Machine
10. Mathematics of K-Means Classification.

List of Practicals:

1. Image Manipulations and Geometrical Transformations
2. Image Filtering and Enhancement
3. Detection of Lines, Edges and Corners
4. Camera Calibration
5. Image Registration
6. Feature Detection and Description by using FAST, ORB
7. Feature Detection and Description by using SIFT, SURF
8. Feature Detection and Description by using LBP, LDP
9. Implementation of Object Tracking
10. Object Classification by using SVM and K-Means

List of Projects:

1. Counting of Objects
2. Object Locator.
3. Barcode Detection
4. Traffic Sign Recognition
5. Motion Detection and Tracking
6. Detection of Potholes
7. Face Recognition
8. Detection of Dents on a Car
9. Detection of Type of Roads (Tar, Cement, and Mud)
10. Detection of Roadside Vegetation, Trees, etc.
11. Detection of Littering / Garbage on the Road
12. Detection of Stray Animals on the Road
13. Detection of Road Intersection (Crossings)
14. Vehicle License Plate Recognition at Security Checkpoints

List of Course Seminar Topics:

1. Bioinspired Stereo Vision Calibration for Dynamic Vision Sensors
2. Low-Power Computer Vision: Status, Challenges, and Opportunities
3. Subpixel Computer Vision Detection based on Wavelet Transform
4. Automatic Counting and Individual Size and Mass Estimation of Olive-Fruits Through Computer Vision Techniques
5. Person Recognition in Personal Photo Collection
6. Measuring Gait Variables Using Computer Vision to Access Mobility and Fall Risk in Older Adults with Dementia
7. Wearable Vision Assistance System based on Binocular Sensors for Visually Impaired Users
8. Edge Detection Algorithm for Musca-Domestica Inspired Vision System
9. Automated Vision Based High Intraocular Pressure Detection using Frontal Eye Images
10. Detection of Possible Illicit Messages using Natural Language Processing and Computer
11. Vision on Twitter and LinkedIn Websites

List of Course Group Discussion Topics:

1. Human Visual System and Computer Vision System
2. Spatial Domain Filtering and Frequency Domain Filtering
3. Features from Accelerated Segment Test Features from Accelerated Segment Test and
4. Oriented Fast and Rotated Brief
5. Local Binary Pattern and Local Directional Pattern
6. K-Nearest Neighbors and K-Means

- 7. Monocular Vision and Stereo Vision
- 8. Image Enhancement and Image Restoration
- 9. Raspberry Pi-4B and Jetson Nano
- 10. Essential Matrix and Fundamental Matrix
- 11. Camera Calibration.

List of Home Assignments:**Design:**

- 1. Depth Calculation based on Monocular Vision
- 2. Depth Calculation based on Stereo Vision
- 3. Automatic Attendance monitoring system
- 4. Detection of Traffic Signals
- 5. Pose Estimation

Case Study:

- 1. Detection of Roadside Infrastructure (Lampposts, Pavement Blocks, Seating Arrangements, Roadside Line Markers, Manholes, Barricades, etc.)
- 2. Vehicle License Plate Recognition at Security Checkpoints
- 3. Detection of Dents on a Car
- 4. Detection of Type of Roads (Tar, Cement, and Mud)
- 5. Hand-Gesture Recognition

Blog

Computer Vision for:

- 1. Mobility of Visually Impaired People
- 2. Avoiding Accidents
- 3. Obstacle Detection and Avoidance
- 4. Patient Monitoring
- 5. Fall detection

Survey:

Computer Vision for

- 1. Differently Abled People
- 2. Computer Vision for Kids Care
- 3. Computer Vision Electric Vehicles
- 4. Computer Vision for Women Safety
- 5. Computer Vision for Teaching-Learning Process at Academic Institutes

Assessment Scheme:

Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

Text Books:

1. Gonzalez, Woods, "Digital Image Processing", Prentice Hall India, 2nd edition.
2. Pratt W.K., "Image Processing", John Wiley, 2001
3. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Publication.
4. Forsyth and Ponce, "Computer Vision-A Modern Approach", 2nd Edition, Pearson Education.
5. R. O. Duda, P.E.Hart, and D.G.Stork, "Pattern Classification", 2nd edition, Springer, 2007.
6. Theodoridis and Koutrombas, " Pattern Recognition", 4th edition, Academic Press, 2009

Reference Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", Thomson Learning.
2. Robert Haralick and Linda Shapiro, "Computer and Robot Vision", Vol I, II, Addison-Wesley, 1993.
3. Ludmila I.Kuncheva, "Combining pattern classifiers", John Wiley and sons Publication.
4. Ethem Alpaydin, " Introduction to Machine Learning", The MIT press.

MOOC's Links and additional reading material:

<https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs58/>

Course Outcomes:

1. Perform Image Enhancement Operations
2. Apply Segmentation Techniques to Divide Image into Parts
3. Develop Feature Vectors for Object Detection Purpose
4. Select Algorithm for Object Recognition
5. Classify Image / Signal / Data/ by using Supervised / Unsupervised Classifier
6. Discuss Epipolar Geometry and Stereo Vision for Depth Calculation.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	1	3	1	0	3	3	3	2	2	1	1
2	3	3	3	1	3	1	0	3	3	3	2	2	1	1
3	3	3	3	3	3	2	0	3	3	3	2	2	3	3
4	3	1	3	1	3	3	0	3	3	3	2	2	3	3
5	3	3	3	3	3	2	1	3	3	3	2	2	3	3
6	3	2	1	3	2	1	1	3	3	3	2	2	1	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels

CO1 : Level 3
 CO2 : Level 4
 CO3 : Level 4
 CO4 : Level 5
 CO5 : Level 5
 CO6 : Level 4

Future Courses Mapping:

1. Pattern Recognition, Deep Learning

Job Mapping:

1. Embedded Engineer
2. Computer Vision Specialist
3. Data Engineer
4. Machine Learning Engineer
5. Data Scientist
6. Engineer-Autonomous Vehicle
7. Research Engineer

ET3206: DIGITAL DESIGN

Course Prerequisites:

Semiconductor devices: FET, MOS operation, biasing techniques. MOS as inverter.

Digital Electronics: Logic Gates, Boolean Algebra, Truth table, K-maps, Combinational Circuits, Sequential Circuits, State Diagrams.

Course Objectives:

Student will be able to

1. Understand the effect of power and frequency of operation of MOS on overall performance.
2. Compare performance of digital logic families
3. Optimizing pipelines for speed, area, power and resources
4. Understanding parallelism of hardware and advantage over sequential processors
5. Design optimized digital circuits in HDL Verilog
6. Generate self-checking test bench for given functionality

Credits: 4

Teaching Scheme Theory: 2 Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

This course emphasizes on the deep understanding of the operation of a transistor. The understanding of the transistor is necessary to model and innovate future process technologies. The basic circuit understanding is essential for achieving the best PPA (Power, performance and area) metrics. A transistor level understanding of the circuits is regularly used for circuit analysis, design and debug in standard cell, methodology development, process technology, memory design, analog design, digital design, physical design teams in the industry. Often, high performance designs need hand instantiation of logic gates to meet the timing at the high clock speeds. For example: CPU, Memory controller cores, PHY designs are high performance cores being clocked at greater than 2-4GHz. The second section of the course emphasizes on the language constructs and a method of implementation of complex logic and functionalities in the SoCs. The language is a powerful tool for keeping the designs technology independent and hence increasing reusability across technology nodes and across designs.

SECTION-1

MOS Inverter: Digital vs Analog vs Discrete vs Continuous, MOS as Switch, Concept of Gate Threshold voltage, MOS structure and working, Types of MOS : Enhancement , Depletion, NMOS , PMOS, Capacitors in MOS, IV Characteristics, Equations, Channel length modulation, its effect on current.

Importance of scaling, dimensions for scaling, types of scaling. Effect on threshold, current, power, delay due to - Constant voltage scaling. Effect on threshold, current, power, delay due to - Constant Field scaling. Comparison of constant voltage and constant field scaling. Short channel and narrow channel effects, DIBL, supporting Equations. Drain punch through, Hot carrier effect, Surface states and interface trapped charge.

CMOS Combinational Circuits: Ratioed logic, Need of PUN and PDN for digital circuits, Design issues of RL in ratioed logic, TPLH vs Power dissipation, CMOS Logic, PUN PDN for CMOS. Inverter and basic logic gates using CMOS, Weak 1 and Strong 0 using NMOS, Weak 0 and Strong 1 using PMOS in CMOS inverter, DCVSL Working, Pass Transistor logic, Level restorer, Transmission Gate logic, Dynamic Logic Design , Speed and power dissipation in dynamic logic, Signal Integrity issues in Dynamic Design, Domino Logic & Optimization of Domino

CMOS Sequential Circuits - Overview of working, Multiplexer based latch, Mux based FF, NMOS only pass transistor logic - FF circuit, Clock overlap issues. C2MOS Logic Working and immunity to clock overlap. TSPC Working. Pipelining - Approach to optimize sequential circuits, Latch vs Register pipeline, NORA CMOS.

SECTION-2

Configurable Hardware: Design options for digital systems, Standard Chips, PLDs, FPGAs and ASICs. VLSI design flow. Role of hardware description languages, motivation. Concurrency in hardware.

Introduction to Verilog HDL: Levels of Design Description, Concurrency, Simulation and Synthesis, Function Verification, Module, System Tasks, Simulation and Synthesis. Verilog Language Constructs and Conventions: Introduction, Keywords, Identifiers, White Space, Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Operators. Gate level modelling and Data flow modelling.

Behavioral modeling : Procedural constructs- initial & always block, procedural assignments – blocking and nonblocking statements, difference in blocking and nonblocking statements, active region, inactive region, event scheduling under stratified event queue, event scheduling

in Verilog, delay timing control, selection statements- if-else, case, iterative statements- while, for, repeat, forever loop. Task, function, system tasks and functions, file I/O system task

List of Tutorials:

1. Moores Law, Technology nodes in VLSI Fabrication
2. VLSI Fabrication process
3. FINFET technology
4. Power Delay optimization
5. Simulation of combinational and sequential circuits in SPICE
6. Simulation Verification & Synthesis
7. Protocol implementation using Verilog
8. High Level Synthesis
9. Filter implementation in HDL
10. Self checking test bench.

List of Practicals:

1. Operation point analysis, DC Analysis and AC analysis of RC network using SPICE.
2. DC analysis of nMOS, pMOS and CMOS Inverter for varying threshold voltage and W/L ratio using SPICE.
3. Transient analysis and Voltage Transfer Characteristics of CMOS inverter using SPICE.
4. CMOS Inverter Layout, Pulse and dc sweep characteristics using Layout editor.
5. CMOS Logic Gate, Pulse and dc sweep characteristics using SPICE
6. CMOS ratioed logic analysis for varying loads using SPICE.
7. Transient analysis of CMOS based 2:4 Decoder
8. Transient analysis of CMOS based 3:2 priority encoder
9. Simulation of Combinational Circuit using Verilog
10. Simulation of Sequential Circuits using Verilog.

List of Projects:

1. To simulate I2C protocol in Verilog HDL
2. To simulate SPI protocol in Verilog HDL
3. To simulate RAM in Verilog HDL
4. To simulate FIFO in Verilog HDL
5. To simulate encryption standard in Verilog HDL
6. To simulate UART in Verilog HDL
7. To simulate CPU in Verilog HDL
8. To simulate electronic voting machine in Verilog HDL
9. To simulate traffic light controller in Verilog HDL
10. To implement filter in Verilog HDL

List of Course Seminar Topics:

1. Moores Law, Technology nodes in VLSI Fabrication
2. VLSI Fabrication process
3. FINFET technology
4. Power Delay optimization
5. Simulation of combinational and sequential circuits in SPICE
6. Simulation Verification & Synthesis
7. Protocol implementation using Verilog
8. High Level Synthesis
9. Filter implementation in HDL
10. Self checking test bench.

List of Course Group Discussion Topics:

1. Emerging Technology for CMOS replacement
2. Comparison of VLSI Fabrication techniques & representation schemes
3. High Level Synthesis vs Verilog which one describes hardware better
4. Bicmos Technology, Combining BJT & MOS, comparison with CMOS, Fabrication flow, Companies using that technology.
5. Different Types of Fabrication Techniques, SOI/ CMOS/ FINFET technologies, Stick diagram representation, Lambda rules, area calculation
6. Semiconductor memories - RAMBUS, SDRAM, DDR RAM etc., DDR Standards, DDR IC manufacturers,
7. Synchronizer techniques for multiblock domain SOCs, Clock domain crossing, MUX synchronizer, FIFO, Handshake
8. Timing issues in datapath design, Clock Skew positive vs negative skew, Metastability
9. Instruction Pipelining, MIPS pipelined data path, Basic 5 stage pipeline, Multicycle pipeline, performance improvement and hazards etc.
10. Fermi energy band diagrams, Band diagram representing NMOS and PMOS accumulation, depletion, inversion stages.

List of Home Assignments:**Design:**

1. Design & Verify packet processor
2. Design AMBA Bus protocol
3. Design of AXB Bus
4. CPU Design
5. Microprocessor design

Case Study:

1. Design & Verify packet processor
2. Design AMBA Bus protocol

Blog : Blog based on course project based reading

1. Memory Technologies
2. Owning a Fab vs Staying Fabless
3. Security Risks in SoCs and Systems
4. Open Source in Semiconductor Industry
5. Moore's Law; Thermal Challenges

Surveys

1. VLSI supply chain security risks and mitigation techniques
2. VLSI Architectures for Image Interpolation
3. Optimal solution for VLSI circuit partitioning in physical design
4. Verilog HDL simulator technology
5. Parallel Multi-core Verilog HDL Simulation
6. Historical Survey of Functional Hardware Languages
7. Survey of High-Level Synthesis Systems
8. Defect tolerance in VLSI circuits: techniques and yield analysis
9. Synchronizer techniques for multi-clock domain SoCs
10. Impact of FSM Design for High-Performance Architecture Evaluation.

Assessment Scheme:

Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

Textbooks:

1. Kang, Sung-Mo, and Yusuf Leblebici. CMOS digital integrated circuits. Tata McGraw -Hill Education, 2003.
2. Rabaey, Jan M., Anantha P. Chandrakasan, and Borivoje Nikolić. Digital integrated circuits: a design perspective. Vol. 7. Upper Saddle River, NJ: Pearson Education, 2003.
3. Palnitkar, Samir. Verilog HDL: a guide to digital design and synthesis. Vol. 1. Prentice

Hall Professional, 2003.

4. Link to e-books <http://www.stem-edu.com/wp-content/uploads/2017/02/Rabaey-Digital-Integrated-Circuits-Asign-Perspective-2Nd-Edition.pdf>

Reference Books:

1. Weste, Neil HE, and David Harris. CMOS VLSI design: a circuits and systems perspective. Pearson Education India, 2015.
2. Ciletti, Michael D. Advanced digital design with the Verilog HDL. Vol. 1. Upper Saddle River: Prentice Hall, 2003.

Moocs Links and additional reading material:

www.nptelvideos.in

<https://nptel.ac.in/courses/108/106/108106158/> IIT Madras

<https://nptel.ac.in/courses/106/105/106105165/> Dr. Indranil Sengupta

Course Outcomes:

Student will be able to

1. Determine MOSFET behavior under dimension scaling
2. Compare performance of CMOS based logic circuit
3. Analyze combinational and sequential circuit for pipelining
4. Describe VLSI design flow and basic Verilog constructs
5. Describe functionality of digital Circuits using Verilog HDL
6. Select Verilog HDL statement for coding and synthesis optimization

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	3	2	3	3	3	3	3	3	3	3
2	2	3	3	2	3	2	3	3	3	2	2	3	2	3
3	2	3	3	3	2	2	3	3	2	2	1	3	2	3
4	3	3	3	2	3	2	3	3	3	3	3	3	3	3
5	3	2	3	3	3	2	3	3	3	3	3	3	3	2
6	2	2	3	3	3	2	3	3	2	3	1	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels

CO1 : Level 3

CO2 : Level 4

CO3 : Level 4

CO4 : Level 5

CO5 : Level 5

CO6 : Level 5

Future Courses Mapping:

CMOS Analog Design, System Verilog.

ET3271: EMBEDDED SYSTEM DESIGN

Course Prerequisites:

Microprocessor & Microcontroller concepts and applications, Assembly language concepts, C programming, Computer architecture and operating system

Course Objectives:

1. Learn designing and programming Embedded Systems for real time applications.
2. Set up and operate Raspberry Pi with different interfaces
3. Develop embedded software using RTOS and implement small programs to solve well-defined problems on an embedded platform.

Credits: 4

Teaching Scheme Theory: 2 Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

SECTION-1

Introduction to embedded system: Introduction to embedded system, hardware and software architecture, RISC and CISC architecture, Processor and memory selection criteria, I/O ,

ARM Processor ARM family, nomenclature, data flow model of ARM7 , registers model of ARM 7, Architecture of ARM7 , operating modes, Exception Handling,

LPC2148 Microcontroller : Features, Block diagram , GPIO, Interrupts, Timers, PLL, ADC/DAC, PWM

SECTION-2

Communication Protocols: UART, RS232, CAN, I2C & SPI Implementation

Raspberry PI : Introduction to Raspberry Pi, setting up Raspberry Pi, Interfacing & Programming Raspberry Pi using Python

RTOS :Characteristics, RTOS kernel services, task management(task states, API,), Task scheduling algorithms , Resource management (synchronization , Mutual Exclusion,

Semaphores) Critical section of code, race condition , Intertask Communication, Priority Inversion, Deadlock, memory management, ISR, Timer.

List of Tutorials:

1. ARM nomenclature and Comparative study of different versions of ARM
2. LPC2148 GPIO
3. LPC2148 Timers and ADC
4. LPC 2148 Interrupts
5. LPC 2148 DAC
6. LPC2148 UART
7. LPC 2148 I2C /SPI protocols
8. Study of various embedded hardware development platforms
9. STudy of different Embedded OS
10. uCOS III RTOS task scheduling /multitasking.

List of Practicals:

1. LPC2148 interface with LED and & 7 segment Display
2. LPC2148 interface with 16 X 2 LCD
3. LPC2148 interface with Matrix Keyboard.
4. LPC2148 interface with temperature sensor and relay.
5. LPC2148 interface with DC Motor
6. Setting up Raspberry Pi
7. GPIO programming with Raspberry pi
8. Task Scheduling for Input and Output Devices using μ COS- II Semaphore
9. Implementation of Message Queue for 3 Tasks on μ COS- II.
10. Implementation of Message Mailbox for 3 Tasks on μ COS- II.

List of Projects:

1. Rolling Display
2. Automatic sanitizer dispenser and water tap
3. Automatic door opener and closure along with display of total count of people gone into the shop/bank.
4. Queue regulation in shop/bank at safe social distance.
5. Image operated bill generating machines at Govt. Ration shops.
6. Mobile app for grocery/vegetable shopkeeper and customer.
7. Home automation.
8. Non touching Electric switches for home/offices/shops
9. Greenhouse farming
10. AC /stepper motor speed control.

List of Course Seminar Topics:

1. Speeding up power estimation of embedded software
2. Battery model for embedded system
3. Integrating security policies with embedded real time systems
4. Real time dynamic voltage scaling for embedded systems
5. Scratchpad memory: A design alternative for cache on chip memory in embedded systems
6. AUTOSAR architecture in Automobiles
7. Performance issues of embedded systems
8. Lin protocol in automobile
9. GPU
10. Reconfigurable processor.

List of Course Group Discussion Topics:

1. Serial interface vs parallel interface
2. Various types of semiconductor memories used in microcontrollers.
3. Wired Vs. wireless interface
4. Industrial communication protocols
5. Microcontroller Vs. FPGA/ASIC
6. OS scheduling algorithms
7. RTLinux Vs uCOS III RTOS
8. uCOS III Vs FreeRTOS
9. CAN Vs MODBUS Protocol
10. Microcontroller based system's Real time testing vs Simulation based testing.

List of Home Assignments:**Design:**

1. Incremental Phase shifter design
2. Prevention system from Locust attack
3. Battery management system in electric vehicle
4. Implementation of CAN protocol
5. Health monitoring system

Case Study:

1. Software development life cycle models
2. ECU in automobiles
3. Aerospace / Aircraft monitor and control

- 4. Electric vehicles and microcontroller application
- 5. Assessment of Malware for embedded Architectures

Blog:

- 1. Protection and Security of RTOS
- 2. Modern embedded system programming: Beyond RTOS
- 3. Role of RTOS in autonomous cars
- 4. Embedded system: A carrier option

Surveys:

- 1. Securing wireless data: design challenges
- 2. Multicore processors architecture
- 3. RTOS and GPOS
- 4. Flexray protocol

Assessment Scheme:

Mid Semester Examination - 10 Marks

Presentation - 15 Marks

Laboratory - 10 Marks

Course Project - 10 Marks

Home Assignment - 10 Marks

Group Discussion - 15 Marks

End Semester Examination - 10 Marks

Comprehensive Viva Voce - 20 Marks

Text Books:

- 1. Sloss Andrew , “ARM system Developer's Guide”, Elsevier Publication
- 2. Dr. K.V.K.K. PrasSad , “ Embedded / Real Time Systems Programming” Black Book, Dreamtech Press,
- 3. Jean J. Labrosse, “MicroC OS II, The Real-Time Kernel”, 2nd edition, CMP Books.

Reference Books:

- 1. Embedded System Design, CMP Books, Arnold S. Berger
- 2. Software introduction” 3rd edition, Wiley, Frank Vahid and Tony Givargis.
- 3. LPC 2148 Datasheet
- 4. LPC 2148 reference manual

MOOC's Links and additional reading material:https://swayam.gov.in/nd1_noc20_cs15<https://nptel.ac.in/courses/106/105/106105193/><https://nptel.ac.in/courses/106/105/106105166/>**Course Outcomes:**

The student will be able to

1. Elaborate Classic ARM processor architecture
2. Design and analyse various peripheral device interfaces with LPC2148 Microcontroller.
3. Compare various communication protocols used in embedded systems
4. Describe Raspberry Pi system.
5. Design and analyse various peripheral device interface with Raspberry Pi
6. Apply uCOS II RTOS in real time application.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	0	0	1	0	0	1	1	2	2	3	3	0	0
2	2	3	3	1	3	3	2	2	3	3	3	3	0	3
3	2	3	3	1	3	3	2	2	3	3	3	3	3	3
4	1	0	3	1	3	0	1	2	3	3	3	2	3	3
5	1	0	3	1	3	3	1	2	3	2	3	3	0	0
6	2	3	0	1	3	2	2	2	3	3	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels

CO1: Level 1

CO2: Level 3

CO3: Level 2

CO4: Level 2

CO5: Level 4

CO6: Level 4

Future Courses Mapping:

Automotive Electronics, Embedded networking

Job Mapping:

System software engineer, Embedded software engineer, System expert, Chip design engineer. Application software engineer in various sectors like automotive, consumer electronics, medical, aviation etc.

ET3283: ENGINEERING DESIGN AND INNOVATIONS-3

Course Prerequisites:

Basic Electronics, Physics, Engineering Mathematics, Statistics, Programming Languages

Course Objectives:

1. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a group to develop team skills and learn professionalism.

Credits: 6

Teaching Scheme: Lab 2 Hours/Week

Course Relevance:

Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. Students can be evaluated for higher order skills of Blooms taxonomy like ‘analyze, design and apply’. This course is capable of imparting hands on experience and self-learning to the students which will help them throughout their career. This is a step ahead in line with national policy of Atmanirbhar Bharat.

Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. This course is designed to encourage and ensure application of technology for solving real world problems using an interdisciplinary approach.

Students need to plan their work in following steps:

1. Formation of project group comprising of 4-5 students. Multidisciplinary groups are allowed
2. A supervisor/mentor teacher assigned to individual groups.
3. Carrying out literature survey
4. Finalization of problem statement
5. Planning the project execution
6. Execution of project and testing
7. Writing a report
8. Publication in the form of research paper/patent/copyright as found suitable by supervisor/mentor

Teacher's Role in PCL:

1. Teacher is not the source of solutions rather he will they act as the facilitator and mentor.
2. To utilize the principles of problems solving, critical thinking and metacognitive skills of the students.
3. To aware the group about time management.
4. Commitment to devote the time to solve student's technical problems and interested in helping students to empower them better.

Student's Role in PCL:

1. Students must have ability to initiate the task/idea they should not be mere imitators.
2. They must learn to think.
3. Students working in PCL must be responsible for their own learning.
4. Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.
5. Students in PCL are actively constructing their knowledge and understanding of the situation in groups.
6. Students in PCL are expected to work in groups.
7. They must develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

Core Technology domains identified for E&TC Engg are as below. However, this list can be extended as per the need of project and multidisciplinary approach

- 1) VLSI Design
- 2) Embedded Systems
- 3) Signal Processing
- 4) Communication
- 5) Machine learning

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

MOOCs Links and additional reading material:

www.nptelvideos.in
<https://worldwide.espacenet.com/>

Course Outcomes:

1. Review the literature to formulate problem statement to solve real world problems.
2. Apply knowledge of technology and modern tools to design solution considering sustainability and environmental issues.
3. Manage project ethically as team member/ lead.
4. Demonstrate effectively technical report/ research paper/ prototype/patent.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	1	0	0	3	3	3	1	2	2	2
2	3	3	3	3	3	3	3	3	3	2	1	2	3	3
3	1	1	1	1	1	2	0	3	3	3	3	2	1	1
4	3	1	1	1	0	0	0	3	1	3	3	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels:

CO1: - Level 3
CO2: - Level 4
CO3: - Level 3
CO4: - Level 4

ET3272: DESIGN AND ANALYSIS OF ALGORITHMS

Course Prerequisites: Basic courses on programming, data structures, Discrete structures, theory of computing.

Course Objectives:

1. Students will gain understanding of asymptotic notations and will be able to apply suitable mathematical techniques to find asymptotic time and space complexities of algorithms.
2. Students will develop ability to formulate computational problems in abstract and mathematically precise manner.
3. Student will gain understanding of different algorithm design paradigms such as divide and conquer, dynamic programming, greedy, backtracking and will apply suitable paradigm for designing algorithms for computational problems
4. Students will develop understanding of notions of NP-hardness and NP-completeness and their relationship with the intractability of decision problems.
5. Students will design randomized, approximation algorithms for some computational problems.

Credits: 4

Teaching Scheme Theory: 2 Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

This is a foundational course for Computer science and Engineering. This course develops algorithmic thinking capability of students. Designing algorithms using suitable paradigm and analysing the algorithms for computational problems has a high relevance in all domains where computer science plays a crucial role (equally in Industry as well as research). This course is also an essential pre-requisite for advanced domain specific algorithmic courses such as Algorithmic Graph Theory, Algorithmic Number Theory, Computational Geometry, Motion planning and Robotics, etc, to give a few examples. Once the student gains expertise in Algorithm design and in general gains ability of Algorithmic thinking, it facilitates in systematic study of any other domain (in computer science or otherwise) which demands logical thinking. This course is also relevant for students who want to pursue research career in theory of computing, computational complexity theory, advanced algorithmic research.

SECTION-1

Basic introduction and time and space complexity analysis:

Asymptotic notations (Big Oh, small oh, Big Omega, Theta notations). Best case, average case, and worst-case time and space complexity of algorithms. Overview of searching, sorting algorithms. Adversary lower bounds (for the comparison-based sorting algorithms, for finding second minima). Using Recurrence relations and Mathematical Induction to get asymptotic bounds on time complexity. Master's theorem and applications. Proving correctness of algorithms. (4 hr)

Divide and Conquer: General strategy, Binary search and applications, Analyzing Quick sort, Merge sort, Counting Inversions, Finding a majority element, Order statistics (randomized and deterministic algorithms), Josephus problem using recurrence, Efficient algorithms for Integer arithmetic (Euclid's algorithm, Karatsuba's algorithm for integer multiplication, fast exponentiation). (4 hr)

Dynamic Programming: General strategy, simple dynamic programming based algorithms to compute Fibonacci numbers, binomial coefficients, Matrix Chain multiplication, Optimal binary search tree (OBST) construction, 0-1 Knapsack, Traveling Salesperson Problem. (7 hr)

SECTION-2

Greedy and Backtracking strategy:

Greedy: General strategy, Analysis and correctness proof of minimum spanning tree and shortest path algorithms, fractional knapsack problem, Huffman coding, conflict free scheduling.

Backtracking: General strategy, n-queen problem, backtracking strategy for some NP-complete problems (e.g. graph colouring, subset sum problem) (7 hr)

Introduction to complexity classes and NP-completeness:

Complexity classes P, NP, coNP, and their interrelation, Notion of polynomial time many one reductions reduction, Notion of NP-hardness and NP-completeness, Cook-Levin theorem. NP-Complete problems (some selected examples from - Satisfiability problem, Circuit-SAT, 3-CNF SAT, vertex cover problem, independent set problem, clique problem, Hamiltonian-circuit problem.

(4hr)

Introduction to Randomized and Approximation algorithms:

Introduction to randomness in computation, Las-Vegas and Monte-Carlo algorithms, Abundance of witnesses/solutions and application of randomization, randomized quick sort, Las-Vegas and Monte-Carlo algorithms for majority search

Introduction to Approximation algorithms for NP-optimization problems, Approximation algorithm for metric Traveling-Sales-Person Problem (metric-TSP). (4 hr)

List of Tutorials:

1. Problem solving based on asymptotic notations, solution of recurrences
2. Problem solving based on Divide and Conquer strategy
3. Advanced problem solving based on Divide and Conquer strategy
4. Problem solving based on Dynamic Programming strategy
5. Advanced problem solving based on Dynamic Programming strategy
6. Problem solving based on Greedy strategy
7. Problem solving based on Backtracking strategy
8. Proving correctness of algorithms: some techniques
9. Adversary lower bound technique
10. Problem solving based on complexity classes, NP-completeness.
11. Randomized Algorithms
12. Approximation Algorithms

List of Practicals:

1. Assignment based on some simple coding problems on numbers, graphs, matrices
2. Assignment based on analysis of quick sort (deterministic and randomized variant)
3. Assignment based on Divide and Conquer strategy (e.g. majority element search, finding kth rank element in an array)
4. Assignment based on Divide and Conquer strategy (e.g. efficient algorithm for Josephus problem using recurrence relations, fast modular exponentiation)
5. Assignment based on Dynamic Programming strategy (e.g. Matrix chain multiplication, Longest increasing subsequence)
6. Assignment based on Dynamic Programming strategy (e.g, All pair shortest path, Traveling Sales Person problem)
7. Assignment based on Greedy strategy (e.g. Huffman encoding)
8. Assignment based on Backtracking (e.g. graph coloring, n-queen problem)
9. Assignment based on Las-Vegas and Monte-Carlo algorithm for majority element search
10. Assignment based on factor-2 approximation algorithm for metric-TSP

List of projects:

1. Applications of A* algorithm in gaming
2. Pac-Man game
3. File compression techniques
4. Solution of Maze (comparing the backtracking based solution and Dijkstra's algorithm)
5. Different exact and approximation algorithms for Travelling-Sales-Person Problem
6. Creation of Maze using backtracking
7. Knight tour algorithms
8. Network flow optimization and maximum matching
9. AI for different games such as minesweeper, shooting games, Hex, connect-4, sokoban, etc
10. SUDOKU solver
11. Graph theoretic algorithms
12. Computational Geometry Algorithms
13. AKS primality testing
14. Algorithms for factoring large integers
15. Randomized algorithms for primality testing (Miller-Rabin, Solovay-Strassen)
16. Slider puzzle game

List of Course Seminar Topics:

1. Divide and Conquer Vs Dynamic Programming
2. Greedy strategy
3. NP-hardness
4. Backtracking strategy
5. Dynamic Programming Vs Greedy
6. Computational Complexity
7. Philosophical relevance of P Vs NP question
8. Complexity classes
9. Space complexity
10. Compression Techniques
11. Real world applications of Graph theoretic algorithms
12. Approximation algorithms
13. Hardness of approximation
14. Pseudorandom number generators

List of Group Discussion Topics:

1. Greedy Algorithms
2. Dynamic Programming strategy
3. Dynamic Programming Vs Greedy
4. NP-completeness
5. P Vs NP question

- 6. Algorithm design paradigms
- 7. Different Searching techniques
- 8. Backtracking strategy
- 9. Relevance of Cook-Levin theorem
- 10. Randomness in computation
- 11. Approximation Algorithms
- 12. Application of Recursion

List of Home Assignments:**Design:**

- 1. Problem solving based on Divide and Conquer strategy
- 2. Problem solving based on Dynamic Programming strategy
- 3. Problem solving based on Greedy strategy
- 4. Problem solving based on Backtracking strategy
- 5. Problems on Randomized Algorithms
- 6. Problems on Approximation Algorithms
- 7. Problems on NP completeness

Case Study:

- 1. AKS primality test
- 2. Quadratic sieve factoring algorithm
- 3. Huffman Encoding, LZW encoding
- 4. Network flow optimization algorithms
- 5. Approximation algorithms for TSP
- 6. Cook-Levin theorem and its relationship with intractability of computational problems
- 7. Sorting techniques

Blog:

- 1. Approximation Algorithms
- 2. Randomized Algorithms
- 3. Computational Geometry Algorithms
- 4. Number Theoretic Algorithms
- 5. Graph Theoretic Algorithms
- 6. P Vs NP Problem
- 7. Complexity classes
- 8. Greedy Algorithms
- 9. Divide and Conquer Vs Dynamic Programming

Surveys:

- 1. Primality Testing Algorithms
- 2. Integer Factoring Algorithms
- 3. NP-complete problems
- 4. Compression Techniques
- 5. Shortest Path Algorithms

<ul style="list-style-type: none">6. Algorithms for finding Minimum Weight Spanning Tree7. SAT solvers

Assessment Scheme:

- Mid Semester Examination - 10 Marks
- Presentation - 15 Marks
- Laboratory - 10 Marks
- Course Project - 10 Marks
- Home Assignment - 10 Marks
- Group Discussion - 15 Marks
- End Semester Examination - 10 Marks
- Comprehensive Viva Voce - 20 Marks

Textbooks:

<ul style="list-style-type: none">1. Cormen, Leiserson, Rivest and Stein "Introduction to Algorithms", PHI 3rd edition, 2009. ISBN 81-203-2141-32. Jon Kleinberg, Eva Tardos "Algorithm Design", Pearson, 1st edition, 2005. ISBN 978-81-317-0310-63. Dasgupta, Papadimitriu, Vazirani "Algorithms" McGraw-Hill Education; 1 edition (September 13, 2006), ISBN-10: 9780073523408, ISBN-13: 978-0073523408
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Reference Books:

<ul style="list-style-type: none">1. Motwani, Raghavan "Randomized Algorithms", Cambridge University Press; 1 edition (August 25, 1995), ISBN-10: 0521474655, ISBN-13: 978-05214746582. Vazirani, "Approximation Algorithms", Springer (December 8, 2010), ISBN-10: 3642084699, ISBN-13: 978-3642084690
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MOOCs Links and additional reading material: www.nptelvideos.in,**Course Outcomes:**

The student will be able –

<ul style="list-style-type: none">1. To formulate computational problems in abstract and mathematically precise manner2. To design efficient algorithms for computational problems using appropriate algorithmic paradigm3. To analyze asymptotic complexity of the algorithm for a complex computational problem using suitable mathematical techniques.4. To establish NP-completeness of some decision problems, grasp the significance of the notion of NP-completeness and its relationship with intractability of the decision problems.

5. To understand significance of randomness, approximability in computation and design randomized algorithms for simple computational problems and design efficient approximation algorithms for standard NP-optimization problems.
6. To incorporate appropriate data structures, algorithmic paradigms to craft innovative scientific solutions for complex computing problems.

CO PO Map:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	0	0	0	0	1	1	1	1	2	3	1
2	3	3	3	0	0	0	0	1	1	1	1	2	3	2
3	3	3	2	3	01	0	0	1	1	1	1	2	3	01
4	3	3	3	3	0	0	0	0	1	1	0	2	3	01
5	3	3	3	2	0	0	0	0	1	1	0	2	3	02
6	3	3	3	0	0	0	0	1	1	1	1	2	3	02

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels:

CO1: Level 2

CO2: Level 3

CO3: Level 3

CO4: Level 5

CO5: Level 5

CO6: Level 2

Future Courses Mapping:

Following courses can be learned after successful completion of this course:

Advanced Algorithms, Computational Complexity, Computational Geometry, Algorithmic Number Theory, Algorithmic Graph Theory.

ET3207: INFORMATION THEORY & CODING TECHNIQUES

Course Prerequisites:

Probability Theory, Basic Maths.

Course Objectives:

- To study various Lossless and Lossy Compression methods
- To compress effectively Text, Signal, and Image
- To generate Linear block codes
- To Encode and decode data effectively

Credits: 4

Teaching Scheme Theory: 2 Hours/Week

Tut: 1 Hour/Week

Lab: 2 Hours/Week

Course Relevance: This course introduces the concept of information theory, Entropy, Compression techniques, coding techniques and models.

SECTION-1

Introduction to Information theory, Discrete memory less channel , Entropy and its properties, Differential entropy and mutual Information, Information Capacity theorem.

Kraft's McMillan Inequality, Source coding theorem, Huffman coding, Shannon-Fano coding, Arithmetic Coding , Dictionary Techniques for lossless compression, Linear Block Codes- Syndrome and error detection, Error detection and correction capacity, Standard array and syndrome decoding, Encoding and decoding circuit, Single parity check codes

SECTION-2

Cyclic Codes, generator polynomial, Generator matrix for systematic cyclic code, Encoding for cyclic code, Syndrome decoding of cyclic codes, Convolutional Codes, State diagram, Polynomial description of convolution code, Generator matrix of convolution code, Tree diagram, Trellis diagram, Viterbi decoding, Binary BCH code, Generator polynomial for BCH code, Decoding of BCH code, RS codes, generator polynomial for RS code, Decoding of RS codes.

List of Practicals:

1. To determine Entropy and information rate for the given source.
2. To implement Huffman code.
3. To implement arithmetic code.
4. To implement LZ77 algorithm.
5. To implement LZ77 algorithm.
6. To implement LZW algorithm
7. To implement linear block codes.
8. To implement cyclic code.
9. To implement convolution code.
10. To implement Viterbi decoder

List of Course Projects:

1. Signal compression with lossless/lossy compression techniques.
2. Image compression with lossless/lossy compression techniques.
3. Text files compression with dictionary techniques.
4. Comparison of various channel coding Techniques.

List of Course Seminar Topics:

1. Data Compression
2. Lossless Compression Techniques
3. Lossy Compression Techniques
4. JPEG Compression Standard
5. Lempel Ziv Dictionary Techniques
6. DCT based Compression
7. Wavelet based Compression
8. Linear block codes
9. Cyclic Codes

List of Course Group Discussion Topics:

1. Need of data Compression
2. Comparison of Lossless and Lossy Compression methods
3. DCT versus DFT Transform
4. Wavelet Transform based Compression
5. Study of File formats
6. Linear Block codes with Applications
7. Convolution versus Cyclic codes
8. Applications of Viterbi coding Technique
9. JPEG versus MPEG Compression

List of Home Assignments:**Case Study**

Compress one Speech/ECG Signal/Image using different compression methods and make a comparative study in terms of compression ratio, efficiency, computational complexity and execution time.

Surveys

Survey of existing lossless and Lossy compression algorithms for ECG Signal Processing.

Design

Design an efficient encoding and decoding algorithm for one Low frequency and one High frequency Text/Signal/Image.

Blog

Suitability of different Compression algorithms for various types of Multimedia Data.

Assessment Scheme:

Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

Textbooks:

1. "Information Theory coding and Cryptography", RanjanBose , 2ndEdition ,McGraw-Hill Publication.
2. " Analog and digital communications ", Hwei Hsu, second edition , Schaum's outlines.

Reference Books:

1. "Digital Communication Fundamentals & applications"; Bernad Sklar, Second Edition, Pearson Education.
2. "Communication Systems", Simon Haykin; Fourth Edition, John Wiley & Sons.
3. "Introduction to Data compression", Khalid Sayood, Morgan Kaufmann Publisher.

Moocs Links and additional reading material: www.nptelvideos.in**Course Outcomes:**

The students will be able to

1. Evaluate the performance of source coding theorem based on entropy.
2. Analyze & implement lossless and Lossy compression techniques.
3. Analyze linear block codes for error detection.
4. Decode cyclic code for error detection.
5. Generate Convolutional code & decode using Viterbi decoding.
6. Analyze RS code

CO PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	0	2	2	0	0	0	0	0	0	0	3	3
2	2	2	0	2	3	1	0	0	0	1	1	0	3	3
3	3	2	0	0	3	1	0	0	0	1	1	0	3	3
4	3	3	0	0	2	1	0	0	0	1	1	0	3	3
5	2	2	0	2	3	1	0	0	0	1	0	0	3	3
6	2	2	0	2	3	1	0	0	0	0	0	0	3	3

Future Courses Mapping:

1. Coding and Data Compression
2. Multimedia Signal processing

Job Mapping:

Job opportunities that one can get after learning this course

- Multimedia Signal Processing Industries
- Software Developer
- Telemedicine based Biomedical Industries
- Entrepreneur

ET3273 WEB TECHNOLOGY

Teaching Scheme

Credits: 4.....

Theory: 2 Hours/Week

Tut: 1 Hours/Week

Lab: 1 Hours/Week

Section 1: Topics/Contents

- **Front End Technology:** Introduction to web technology, internet and www, Web site planning and design issues. HTML elements: headings, paragraphs, line break, styles, colors, fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5,CSS.(5)
- **Client-Side Technologies:** JavaScript: Overview of JavaScript, Data types, Control Structures, Arrays, Functions and Scopes, Forms Validation, Objects in JS, DOM: DOM levels, DOM Objects and their properties and methods, Manipulating DOM. (5)
- **Server-Side Technologies:** PHP: Introduction to PHP, Features, sample code, PHP script working, PHP syntax, conditions & Loops, Functions, String manipulation, Arrays & Functions, Form handling, Cookies & Sessions, File Handling, Exception Handling, E-mail validations .(5)

Section2: Topics/Contents

- **MySQL with PHP:** Introduction, built-in database functions, connecting to a MySQL, selecting a database, building and sending query to database engine, retrieving, updating and inserting data. (2)
- **React :**Introduction to React, React component, JSX, Render function, Component API, Component lifecycle, State, Props, Mixins, Component composition, Pass data from parent to child, Pass data from child to parent, Component styling, Forms, Events, Refs, Keys, Router, Flux.(6)
- **Node JS :** Introduction to Node JS, Installation of Node JS, Node JS Modules, Node Package Manager (npm), Creating Web server, File System, Express JS, Serving Static Resources, Database connectivity.(5)

List of Practicals: (Any Six)

1. Develop a basic web page using HTML tags.
2. Create an admission Template form for VIT admission Process? Perform the validation for email and phone no fields (Develop a responsive web site for your CV having video background for first page and perform the validation using email or mobile number as username and a password of

min length consisting at least one uppercase letter one digit and one special character.)

3. Write a JavaScript program to reverse the elements of a given array.
4. Installation and configuration and testing working of XAMPP server for local host.
5. Write a PHP program to create a simple calculator that can accept two numbers and perform operations like add, subtract, multiplication and divide.
6. Design a dynamic web application using PHP and MYSQL as back-end for student data with insert, delete, view and update operation.
7. Design and implement a website using REACT, Spring Boot and MySQL/Oracle.
8. Design and implement a website using REACT, Node Js and MySQL/Oracle.

List of Project areas:

1. Develop a Website with NLP as a backend
2. Student Grievance System
3. Workflow Management System for MNC
4. Browser-based Game Website using HTML, CSS, JavaScript, Bootstrap
5. Develop an web application that help to farmers to solve their farming problems
6. GST Billing Software for Small Business
7. Online Crime Reporting System using PHP
8. Develop an Online College Voting System
9. Develop an Online Loan Processing System for Farmers.

Text Books: *(As per IEEE format)*

1. Kumar, A., *Web technologies*, CRC press, 2019
2. Gupta, R., *Internet & Web Technologies*, Engineering Handbook, 2019
3. Martin, M.G., *Programming for Beginners: 6 Books in 1 – Swift+PHP+Java+Javascript+Html+CSS: Basic Fundamental Guide for Beginners*, independently published, 2018
4. *Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5*, O'Reilly Media; 5th edition, 2018
5. Kohli, S., *Web Technologies*, PPB Publications, 2015
6. Adam Bretz & Colin J Ihrig, "Full Stack Javascript Development with MEAN", SPD, First Edition 2015, Indian Reprint September 2015
7. Giulio Zambon, "Beginning JSP, JSF and Tomcat", Apress Publication, Second Edition, 2013
8. Jeremy McPeak & Paul Wilton, "Beginning JavaScript", Wrox Publication, Fifth Edition, 2015
9. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.

10. Robert W. Sebesta: *Programming the World Wide Web, 4th Edition, Pearson education, 2008.*

Reference Books: (As per IEEE format)

1. Marty Hall, Larry Brown, "Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
2. H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.
3. Chris Bates: *Web Programming Building Internet Applications, 3rd Edition, Wiley India, 2006.*
4. Xue Bai et al: *The web Warrior Guide to Web Programming, Thomson, 2003*

Course Outcomes:

The student will be able to –

On the completion of course, student will able to

1. Create front end web pages using HTML and CSS tags and attributes
2. Provide validation mechanism and event handling in a website using javascript as a front end technology
3. Differentiate between client-side and server-side validation.
4. Integrate front end with serverside and backend technologies for commercial websites using PHP and Mysql
5. Build single page applications using REACT as a reusable UI component technology as client side technology and Node Js as server side technologies
6. Design and develop three tier enterprise application using client side, server side and back end

CO Attainment Level CO1: - Level 2 CO2: - Level 2 CO3: -

Level 3 CO4: - Level 3 CO5: - Level 4 CO6: - Level 4

CO PO Map																
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2		
1	0	3	0	0	3	2	0	3	3	2	3	3	0	2		
2	0	0	2	0	3	2	0	3	3	2	3	3	0	2		
3	0	0	3	0	3	2	0	3	3	2	3	3	0	2		
4	0	3	0	0	3	2	0	3	3	2	3	3	0	2		
5	0	3	2	0	3	2	0	3	3	2	3	3	0	2		
6	0	3	3	0	3	2	0	3	3	2	3	3	0	2		

ET3265 : CONTROL SYSTEMS

Course Prerequisites:

Linear algebra Calculus

Credits:4

Teaching Scheme Theory: 2 Hours/Week

Tut: 1 Hour/Week

Lab: 2 Hours/Week

SECTION-1

Components of control system, Mathematical Modeling of physical systems, Block Diagram Algebra, Signal flow graph, Time Domain Analysis: Standard test signals, Time response and specifications of first order and second order systems, Routh Stability Criteria, Root Locus Technique, Frequency domain specification.

SECTION-2

Frequency Domain Analysis: Frequency response, Bode plot, Polar plot, Nyquist plot and stability criterion. PID Controllers, Introduction to Lead and Lag compensation circuits, State Variable analysis.

List of Practicals:

1. Step, ramp and impulse response of transfer function.
2. Time response of first order system
3. Time response of second order system
4. Mathematical modeling of physical system.
5. Frequency response analysis using Bode plot
6. Frequency response analysis using Nyquist Plot.
7. Study of PID Controller.
8. Designing of Lead, Lag and Lead-Lag Networks
9. DC Position control system.
10. Simulation of state space model.

List of Course Projects:

1. Simulation of given electrical/mechanical system.
2. Linear System Analysis (Time-Domain Analysis, Error –Analysis) using MATLAB
3. Speed control of DC motor.
4. Implementation of op amp based PID controller.
5. Designing of Lead-Lag Compensators for Systems
6. Designing with State Feedback System
7. Simulation of fuzzy control application
8. Design and implementation of filter.
9. Automated Steering control system
10. Automotive suspension system

List of Course Seminar Topics:

1. Electromagnetic levitation: concepts, control and applications
2. Fuzzy logic control
3. Smart control loops in automobile
4. Application of Laplace Analysis to Control
5. A day without control system
6. Frequency domain analysis and stability
7. Time domain analysis and stability
8. Actuators in control system
9. Development of control engineering methods
10. Feedback components in control system

List of Course Group Discussion Topics:

1. Instability in Control System: facts, causes, effects and solution
2. Solving mechanical modelling of system: Force-voltage analogy or Force-current analogy
3. Who serves the stability analysis most: Time domain or frequency domain?
4. Implementing PID controller: problems, challenges and solution
5. Feedback: Impact on system performance
6. Do alone poles curb on system performance?
7. Should Nyquist analysis be made compulsory to describe frequency response of the systems?
8. Steady state error: causes and analysis
9. Effectiveness of Open loop control system and closed loop control system
10. Bode plot or Root locus-a right choice?

List of Home Assignments:**Case Study:**

1. Flight control systems
2. Applications of control loops in chemical processes
3. PID controllers tuning methods with example
4. Multivariable control system
5. Intelligent control system

Surveys:

1. Software toolkits for control algorithm simulation
2. Pneumatic and hydraulic actuators
3. Feed forward control systems
4. Servomechanism
5. Networked control systems

Design:

1. Mathematical modeling of thermal system
2. Mathematical modeling of hydraulic system
3. Cascade lead – lag compensator design
4. Controller design using Bode plot
5. Printwheel system with belt and pulleys

Blog:

1. Electromagnetic levitation: concepts, control and applications
2. Fuzzy logic control
3. Smart control loops in automobile
4. Application of Laplace Analysis to Control
5. A day without control system

Assessment Scheme:

Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

Text Books:

1. K. Ogata, “Modern Control Engineering”, Fourth edition, Pearson education India.
2. I. J. Nagarth and M. Gopal, “Control Systems Engineering”, Third Edition, New age International Publishers, India.

Reference Books:

1. B. C. Kuo, "Automatic control systems", Seventh Edition, Prentice, Hall of India.
2. Norman S. Nise, "Control systems engineering", Third Edition, John Wiley and sons, Inc, Singapore.

Moocs Links and additional reading material: www.nptelvideos.in**Course Outcomes:**

CO 1: Model a given system using transfer function approach
 CO 2: find steady state and transient response of control systems
 CO 3: Analyze given system for stability using root locus.
 CO 4: Demonstrate various techniques of frequency domain analysis
 CO 5: Analyze given system for stability in frequency domain.
 CO 6: Model a given system in state space.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	0	0	1	0	0	0	0	0	0	2	0	0
2	2	2	0	0	0	0	0	0	2	0	0	0	2	0
3	2	2	0	0	1	0	0	0	0	0	1	2	0	0
4	3	2	2	0	2	0	0	0	2	1	1	0	2	2
5	3	2	2	0	2	0	0	0	2	1	1	0	2	2
6	3	0	2	0	2	0	0	0	2	1	1	2	2	0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

FF:654

ET3274: OPERATING SYSTEMS

Course Prerequisites: Basics of computer system, data structures and any programming language.

Course Objectives:

1. To understand the basic concepts and functions of Operating System.
2. To gain knowledge of process synchronization and its mechanism.
3. To get familiar with CPU scheduling algorithms.
4. To discuss different deadlock handling mechanisms.
5. To learn memory management techniques and virtual memory.
6. To discuss I/O management and file management.

Credits: 4

Teaching Scheme Theory: 2 Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

This course focuses on functions of operating system. Operating system is system software that manages resources of the computer system and simplifies applications programming. The Operating System acts as a platform of information exchange between your computer's hardware and the applications running on it.

SECTION-1

Introduction: Interaction of OS and Hardware, Functions of OS, OS Services, Types of OS: Batch, Multiprogramming, Time Sharing, Parallel, Distributed & Real-time OS. OS Commands, System Calls, Types of System Calls.

Process management: Concept of Process, Process States: 2, 5, 7 State Models, Process Structure: Process Control Block, Threads, Thread implementations – User Level and Kernel Level Threads, Concurrency: Issues with Concurrency, Principles of Concurrency, Critical Section Problem, Semaphores and Mutex, Classical Process Synchronization Problems

CPU Scheduling: Uniprocessor Scheduling, Scheduling Algorithms: First Come First Serve (FCFS), Shortest Job First (SJF), Round Robin and Priority.

SECTION-II

Deadlock: Principles of Deadlock, Necessary Conditions for a Deadlock: Mutual Exclusion, Hold and Wait, No Pre-emption, Circular Wait, Handling Deadlocks: Prevention, Avoidance, Bankers Algorithm.

Memory Management: Logical vs Physical Address Space, Memory Partitioning, Fragmentation, Segmentation, Address Translation, Placement Strategies: First Fit, Best Fit, Next Fit and Worst Fit, Paging and Virtual Memory: Page Table Structure, Page Size, Page Replacement Policies: First In First Out (FIFO), Least Recently Used (LRU) and Optimal.

I/O Management: I/O Devices Types and Characteristics, Secondary Storage: Disk Structure, Disk Scheduling Algorithms: First Come First Serve (FCFS), Shortest Seek Time First (SSTF), SCAN, C-SCAN, LOOK and C-LOOK.

List of Tutorials:

1. Comparison of different Operating Systems
2. Linux file hierarchy structure/ File system hierarchy Standard
3. Linux commands
4. Operating system structures
5. File system in Windows and Linux
6. CPU scheduling algorithms
7. Deadlock avoidance algorithm
8. Memory management techniques
9. Page replacement algorithms
10. Disk scheduling algorithms

List of Practicals:

1. Execution of Basic Linux commands.
2. Execution of Advanced Linux commands.
3. Shell scripting program.
4. Program for demonstrating use of different system calls.
5. Implementation of multithreading for Matrix Operations using pthreads.
6. Implementation of Classical problems using Threads and Mutex
7. Implementation of Classical problems using Threads and Semaphore.
8. Program to compute finish time, turnaround time and waiting time for the following algorithms:
 - a. First come First serve b) Shortest Job First (Preemptive and Non Preemptive)
 - b. Priority (Preemptive and Non Preemptive) d) Round Robin
9. Program to check whether given system is in safe state or not using Banker's Deadlock Avoidance algorithm.

10. Program for following placement algorithm check whether memory can be allocated to given process or not by using following methods
 - a. First fit
 - b) Best fit
 - c) Worst fit
 - d) Next fit
11. Program to calculate the number of page faults for a reference string for the following page replacement algorithms:
 - a) FIFO
 - b) LRU
 - c) Optimal
- 2) Program to implement the following disk scheduling algorithms:
 - a) FCFS
 - b) SCAN
 - c) C-SCAN
 - d) SSTF

List of Projects:

1. Design and implementation of a Multiprogramming Operating System: Stage I
 - i.CPU/ Machine Simulation
 - ii. Supervisor Call through interrupt
2. Design and implementation of a Multiprogramming Operating System: Stage II
 - i. Paging
 - ii. Error Handling
 - iii. Interrupt Generation and Servicing
 - iv. Process Data Structure
3. Design and implementation of a Multiprogramming Operating System: Stage III
 - i. Multiprogramming
 - ii. Virtual Memory
 - iii. Process Scheduling and Synchronization
 - iv. Inter-Process Communication
 - v. I/O Handling, Spooling and Buffering

List of Course Seminar Topics:

1. Different File Systems in Windows and Linux OS
2. Operating System generations
3. OS Structures
4. System call Vs API
4. Classical process synchronization problems
5. Process Vs Threads
6. Virtual Machines
7. Real Time Scheduling
8. Booting Process of different Operating Systems.
9. Protection and Security in Operating System
10. Flynn's taxonomy

List of Course Group Discussion Topics:

1. Interprocess Communication (IPC)
2. Role of Operating system
3. 32 bit Vs 64 bit OS
4. Storage structures and their tradeoffs
5. Disk Scheduling
6. Desktop OS Vs Mobile OS
7. Security Vs Protection in OS
8. I/O processors
9. Linux Vs Windows OS
10. Best OS for smartphones

List of Home Assignments:**Design:**

1. Report Generation using Shell Script an AWK
2. Library Management System using shell
3. Inter Process Communication in Linux
4. Design any real time application using job scheduling
5. Design any application using Android

Case Study:

1. Distributed Operating System
2. Microsoft Windows 10
3. VMware
4. Linux
5. Android

Blog

1. Operating System Forensics
2. Open Source OS Vs Commercial OS
3. Protection and Security of OS
4. Comparative study of different mobile OS
5. Operating Systems for IoT Devices

Surveys

1. A survey of Desktop OS
2. Analysis and Comparison of CPU Scheduling Algorithms
3. A Survey of mobile OS
4. Parallel Computing
5. Malware Analysis, Tools and Techniques

Assessment Scheme:

1. Home Assignment: Design, Case Study, Blog and Survey
2. MCQ
3. CVV
4. Seminar
5. Group Discussion
6. LAB-Course Assignment and Project Evaluation

Text Books:

1. Stalling William; "Operating Systems"; 6th Edition, Pearson Education;
2. Silberschatz A., Galvin P., Gagne G.; "Operating System Concepts"; 9th Edition; John Wiley and Sons;
3. Yashavant Kanetkar; "Unix Shell Programming"; 2nd Edition, BPB Publications
4. Sumitabha Das; "Unix Concepts and Applications"; 4th Edition, TMH.

Reference Books:

1. Silberschatz A., Galvin P., Gagne G; "Operating System Principles"; 7th Edition, John Wiley and Sons.
2. Forouzan B. A., Gilberg R. F.; "Unix And Shell Programming"; 1st Edition, Australia Thomson Brooks Cole.
3. Achyut S. Godbole , Atul Kahate; "Operating Systems"; 3rd Edition, McGraw Hill.

Moocs Links and additional reading material:

1. www.nptelvideos.in
2. <https://www.udemy.com/>
3. <https://learn.saylor.org/>
4. <https://www.coursera.org/>
5. <https://swayam.gov.in/>

Course Outcomes:

The student will be able to

1. Examine the functions of a contemporary Operating system with respect to convenience, efficiency and the ability to evolve.
2. Demonstrate knowledge in applying system software and tools available in modern operating system
3. Apply various CPU scheduling algorithms and process synchronization mechanisms to construct solutions to real world problems.
4. Identify the mechanisms to deal with Deadlock.
5. Illustrate the organization of memory and memory management techniques
6. Analyze I/O and file management techniques for better utilization of secondary memory

CO PO Map:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	0	0	0	0	0	1	1	0	1	1	1
2	2	2	3	0	1	1	0	0	1	1	1	1	3	1
3	2	1	0	0	3	2	0	1	1	1	0	1	1	1
4	1	0	0	0	1	2	0	0	1	1	0	1	3	1
5	2	1	3	0	1	2	0	1	1	1	0	1	3	1
6	2	1	1	0	1	1	0	1	1	1	0	1	1	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels:

CO1- Level 2
 CO2- Level 2
 CO3- Level 3
 CO4- Level 4
 CO5- Level 4
 CO6- Level 3

Future Courses Mapping:

High Performances Computing, System Programming

Job Mapping:

Linux Administration, Kernel Developers, Application Developers, System Programmer, System Architect

FF No.: 654

ET3277: DIGITAL COMMUNICATION**Course Prerequisites:**

Fourier series, Fourier transform, probability theory, Analog communication.

Course Objectives:

- 1.** Understand digital communication systems.
- 2.** The basics of Sampling Theorem & Aliasing Effect.
- 3.** Brief about digital modulators and receivers.
- 4.** Build an understanding of Spread Spectrum Techniques
- 5.** Understand Digital Communication Techniques

Credits:4**Teaching Scheme Theory: 2 Hours/Week****Tut: 1 Hours/Week****Lab: 2 Hours/Week****Course Relevance:**

Communication engineering concerned with the sending and receiving of signals especially by means of electrical or electroacoustic devices and electromagnetic waves. Today, communications is the largest sector of the electronics field with the most employees and the largest equipment sales annually. In addition, wireless, networking, or other communication technologies are now contained in almost every electronic product. This makes a knowledge and understanding of communication a must rather an option for every student. Rapid development in electronic communication systems is changing the face of human civilization, especially due to the convergence of wireless voice/data communications and Internet technologies. Analog and digital communication is a core subject of Electronics and Communication Engineering.

SECTION-1

Introduction to digital communication, Sampling, reconstruction, ideal sampling, Flat top & Natural Sampling Aliasing, Aperture effect. Pulse code modulation & reconstruction, Quantization noise, Companded PCM, Delta modulation, Adaptive delta modulation, Differential PCM, ISI and eye diagram.

Digital modulation techniques such as Binary Phase Shift Keying, Quadrature Phase Shift Keying, M-Ary PSK, Quadrature Amplitude Shift Keying, Binary Frequency Shift Keying, M-Ary Frequency Shift Keying, Minimum Shift Keying

Base Band signal receiver ,Derivation for Error prob of int. & dump Filter, Optimum Filter, white noise matched filter, probability error of match filter, correlation, FSK, PSK, non-coherent detection of FSK, DPSK, QPSK, Calculation of error probability for BPSK & BFSK , Signal Space to calculate Probability of error.

SECTION-2

Pseudo-random Sequence, Direct Sequence Spread Spectrum Phase Shift Keying block details & mathematical treatment, Power Spectrum Density curves, Jamming margin and processing gain, Probability of error, Frequency Hop Spread Spectrum

CDMA, TDMA, FDMA, Kepler's Laws, Satellite orbits, Satellite system link models, Satellite system parameters and link budget.

Forward error correcting codes, block codes, cyclic codes, convolutional codes, turbo codes, trellis codes.

List of Tutorials:

1. PAM- TDM
2. Code Modulation.
3. Pulse Code Modulation Companding.
4. Differential PCM
5. Adaptive Delta Modulation
6. Study of data formats.
8. To Study QAM.
9. PN Sequence Generator
10. Study of FHSS
11. Study of Satellite Receiver.

List of Practicals:

1. Verification of Sampling Theorem (PAM).
2. To Study PCM (Tr & Rx)
3. To Study DM (Tr & Rx)
4. To Study QPSK
- 5.. To Study BFSK.
6. To Study DS-SS PSK.
7. To study PN Sequence Generation
8. Simulation of GMSK
9. Simulation of QAM

List of Course Projects:

1. Simulation of Digital Communication System
2. Double SideBand –Suppressed Carrier Amplitude Modulator
3. Analog to Digital Conversion
4. BASK modulator & Demodulator
5. Simulation of QPSK modulator and Demodulator
6. GSM based home Security
7. Precision agriculture using GSM
8. Digital comm system using BPSK for a Industry for 50 mtr distance

List of Course Seminar Topics:

1. Pulse-Code Modulation - An Overview
2. Introduction to Dolby Digital Plus, an Enhancement to the Dolby Digital Coding System
3. Simulation of Bit Error Performance of FSK, BPSK, and pi/4 DQPSK in Flat Fading Indoor Radio Channels Using a Measurement-Based Channel Model
4. Frequency-hop spread Spectrum with QAM and Error-Control Coding.
5. An Overview of Sustainable Green 5G Networks
6. An automatic digital modulation classifier for measurement on telecommunication networks
7. An overview of feature-based methods for digital modulation classification
8. A new bandwidth efficient transmit antenna modulation diversity scheme for linear digital modulation
9. Analog & Digital Modulation Techniques: An overview
10. Bandwidth-efficient digital modulation with application to deep space communications

List of Course Group Discussion Topics:

1. Impact of new media on Radio broadcast
2. Time domain versus Frequency domain analysis for signals and Modulation Techniques.
3. Digital Satellite Communication
4. Digital Modulation Techniques for 5G
5. 5G Vision
6. Jamming against digital communication
7. Error Control Techniques
8. Equalization in Digital Communication
9. Wireless Digital Communication
10. Digital Communication and Smart Building Solutions

List of Home Assignments:**Case Study:**

1. HAM Radio (“The Utilization Of Amateur Radios In Disaster Management”)
2. LEO digital satellite communication for DTH services.
3. Software Defined Radio
4. WiTricity technology for industrial applications
5. RFCs for wireless TCP based reliable communication

Surveys:

1. 5G
2. Modulation techniques in Industrial Communication
3. AM Radio Transmitter
4. IEEE Wireless Communication standards
5. Digital Communication in Software Defined Networks

Design:

1. 16-ary QAM
2. PN Sequence Generator & demodulator
3. Line Encoder Generator
4. Integrator and Dump Filter for Baseband reception
5. Design a Digital communication framework for irrigation system

Blog:

1. Receiver performance characteristics
2. Antennas for 5G network at Home & Office
3. OFDM
4. MIMO
5. Forward error correction

Assessment Scheme:

- Seminar – 15 Marks
- Group Discussion – 15 Marks
- Home Assignment – 10 Marks
- Course Viva – 20 Marks
- MSE – 10 Marks
- ESE – 10 Marks
- Lab work – 10 Marks
- Course project -10 Marks

Text Books:

- 1. Taub Schilling, ‘Principles of communication system’, Tata McGraw Hill, 2nd Edition
- 2. B.Sklar , ‘Digital Communication’, Pearson, 2nd edition

Reference Books:

- 1. Simon Haykin , ‘Digital Communications’, Wiley Publications, 4th edition
- 2. Carlson , ‘Communication System’, McGraw Hill, 4th edition

Moocs Links and additional reading material: www.nptelvideos.in**Course Outcomes:**

- 1. Analyze analog modulated signal and their spectrum
- 2. Illustrate sampling theorem along with line coding techniques.
- 3. Evaluate modulation techniques with respect to bandwidth, Euclidean distance.
- 4. Discuss basic terminologies used in spread Spectrum
- 5. Analyze baseband reception.
- 6. Design forward error correcting codes

Future Courses Mapping:

Courses that can be taken after completion of this course:

- 1. Advances in Digital Communication
- 2. Wireless Communication
- 3. Mobile Communication
- 4. Antenna and Microwave Techniques
- 5. Audio and video processing
- 6. Advanced High Speed Networking
- 7. Network and Cyber Security

CO Attainment Levels:

- CO1:- Level 2
- CO2:- Level 3
- CO3:- Level 4
- CO4:- Level 2
- CO5:- Level 3
- CO6:- Level 3

Job Mapping:

Job opportunities that one can get after learning this course

The two major types of technical positions available in the communication field are Engineers and Technicians. Engineers design communication equipment and system engineers work from specifications and create new equipment or systems which are then manufactured. Some engineers specialize in design other work in manufacturing, testing, quality control and management. Engineers may serve as field service personnel, installing and maintaining complex equipment and systems. There are many outstanding jobs in technical sales, technical writer and as a trainer. Four major segments of industry are manufacturing, resellers, service organization and end users. The major categories in communication field are Telephone companies, Radio users (Mobile, Marine, Aircraft etc), Radio and TV broadcast stations and Cable TV companies, Business and industries of satellite, networks etc, Transportation companies (Airline, Shipping, Railroads), Government and Military.

ET3285: COMPUTER NETWORK SECURITY**Credits: 04****Teaching Scheme: Theory 02 Hours / Week****Lab 02 Hours / Week
Tutorial 01 Hours / Week****Section 1: Topics/Contents****Section 1****Computer Networking**

- ISO OSI
- TCP/IP
- Wired /Wireless Communication
- LAN/MAN /WAN/IOT/CLOUD etc.

Introduction to security

- Need for Security
- The OSI Security Architecture
- Security Attacks
- Security Services
- Security Mechanisms
- A Model for Network Security

Network Security Fundamentals

- Security Through Network Devices
- Security Through Network Technology
- Security Through Network Design Elements

Section2: Topics/Contents**Symmetric Ciphers**

- Substitution & Transposition Techniques
- Block Cipher
- DES
- Stream Ciphers
- RC4

Public Key Cryptography

- Need and Principles of Public Key Cryptosystems
- RSA Algorithm
- Key Distribution and Management
- Diffie-Hellman Key Exchange
- Digital Signatures

Internet Security

- Firewalls
- IP Security
- VPN
- Intrusion Detection
- Web Security
- SSL
- TLS

List of Practicals:

- Study the use of network tools like WHOIS, dig, traceroute, nslookup
- Setting up a computer network.
- Implement HTTP, SMTP, DNS, etc.
- Implement Basic Encryption Algorithm
- Breaking the Shift Cipher
- Implement the RSA algorithm.
- Implement the Diffil-Hellmankey exchange algorithm.
- To Capture the network traffic and understand the network protocol using Wireshark/packet capturing tool.
- Firewall Implementation and Testing
- Demonstration of Security Protocols
- Use the Nessus tool to scan the network for vulnerabilities.
- Develop a program for port scanning.
- Develop a program for penetrating testing.

List of Project areas:

- Design a System to develop a analyzer which will differentiate between different vulnerability and packets entered using it.
- Securing Video Conferencing App for online meetings
- Steganography for Image/Video/Files
- Secure Image display on online social media.
- Secure transfer of government subsidies to farmers/BPL people/ students etc
- Authentication of users for various applications for integrity, availability, confidentiality.
- Implementing a system for detecting the modification of videos/images on social media
- Secure App for online exams detecting Keystroke and camera movements.
- A system to detect the difference between the voice edited in the audio/video
- A System to check the vulnerabilities in the websites.

List of Course Group Discussion Topics:

- Security Issues in Android and IOS devices
- Industry 4.0 and security
- Blockchain and E-voting system
- Security of Aadhar Card and other digital cards
- Automated Home Appliances and Security
- Programming Bugs and Malicious code in information security
- Indian Cyber laws and Deficiencies

- Social Media and Cyber Security
- Need of cyber crime and security in school education.

Text Books: (As per IEEE format)

- Behrouz A Forouzan, Data and Communications and Networking, Fifth Edition, McGraw Hill, Indian Edition
- Cryptography and Network Security: Principles and Practices by W. Stallings, Prentice Hall, 5th Edition, ISBN-10: 0136097049
- CompTIA Security+ Guide to Network Security Fundamentals, Mark Ciampa, 5th Edition, ISBN-10: 1305093917
- Principles of Computer Security: CompTIA Security+ and Beyond by Wm. A. Conklin et al., McGraw Hill, 3rd Edition, ISBN-10: 0071786198

Reference Books: (As per IEEE format)

- James F Kurose and Keith W Ross, Computer Networking, A Top-Down Approach, Sixth edition, Pearson, 2017 .
- Wade Trappe, Lawrence C Washington, “Introduction to Cryptography with coding theory”, Pearson.
- “Cryptography & Network Security”, PHI 4, Forouzan.
- “Cryptography & Network Security”, Mc Graw Hill, Atul Kahate
- <https://nptel.ac.in/courses/106105031/>
“Cryptography and Network Security by Debdeep Mukhopadhyay, IIT Kharagpur”
- <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-858-computer-systems-security-fall-2014/index.htm>
“Computer Systems Security by Nickolai Zeldovich & James Mickens, MIT”
- Vlabs, “Cryptography Lab”: <http://cse29-iiith.vlabs.ac.in/>

Course Outcomes:

The student will be able to –

After successful completion of the course, the learners would be able to

- Present an overview of the main concepts wired and Wireless networking and Protocols.
- Develop the concept of Security needed in Communication of data through computers and networks along with Various Possible Attacks.
- Design and protect any network from the threats.
- Understand Various Encryption mechanisms for secure transmission of data.
- Do research in the emerging areas of cryptography and network security.
- Implement various networking and Web security protocols.

Future Courses Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO5	P O 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	
1	1	1	1	1	1	2	1	2	2	2	1	1	1	1	
2	1	1	1	1	1	1	1	2	2	2	1	1	1	1	
3	1	2	1	1	1	1	1	2	2	2	1	2	2	2	
4	1	2	2	1	1	1	0	2	2	2	1	2	2	2	
5	1	2	2	1	2	2	1	3	2	2	1	2	3	2	

CO	PO 1	PO 2	PO 3	PO 4	PO5	P O 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
1	1	1	1	1	1	2	1	2	2	2	1	1	1	1
2	1	1	1	1	1	1	1	2	2	2	1	1	1	1
3	1	2	1	1	1	1	1	2	2	2	1	2	2	2
4	1	2	2	1	1	1	0	2	2	2	1	2	2	2
5	1	2	2	1	2	2	1	3	2	2	1	2	3	2

6	1	1	2	1	3	2	1	3	2	2	1	3	2	2
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

CO Attainment Levels:

CO1:- Level 3

CO2:- Level 2

CO3:- Level 5

CO4:- Level 4

CO5:- Level 3

CO6:- Level 2

ET3203: POWER ELECTRONICS AND DRIVES

Course Prerequisites:

Semiconductor Devices, Electronics Circuits, Fourier Series Representation, Basics of Electrical Circuits and Machines

Course Objectives:

The student will be able to –

1. Understand uses of power devices in power converters.
2. Examine the performance of controlled converter fed DC Drives.
3. Observe the performance of AC voltage controllers.
4. Examine the performance of inverter fed AC Drives.
5. Use DC to DC converters for relevant applications .
6. Apply the knowledge of power converters for real life applications.

Credits: 4

Teaching Scheme:2 Hours / Week

Theory: 2 Hours / Week Lab/ Project: -2 Hours / Week

Course Relevance:

There is an encouraging growth in power electronics technology creating an impact over electrical energy sectors. To meet the growing demand of power uses, converters are used as suitable to the applications. The research on power devices is improving the performance of these power converters. Also, as most of the real world applications use machines with it's optimum performance, schemes can be implemented through an integration of power electronics and electrical machines which will serve as electrical drives.

In view of this technologically advancing area, course on power electronics introduces the learner (student), power devices and different power converter topologies with the judgement of it's performance when used for control of power utilization and drives.

SECTION-1

Power Devices: - Power Diode and BJT, SCR, Triac, MOSFET, IGBT- Structure, Characteristics, LDMOS-Structure and I-V, Selection criterion, Driver Circuits, Protection of power Devices: Snubber circuit.

DC Drives: Controlled bridge rectifiers and its analysis, DC Motors starting, characteristic and speed control, DC drive requirements.

AC Voltage Controllers: Configurations and operation.

SECTION-2

Switched mode DC/DC Converters: Linear power supplies, switching power supplies, step down converters, step up converter, buck boost converter - continuous and discontinuous conduction, fly back converters, forward converters, push pull converters.

AC Drives: Single phase inverters – Working of push pull inverters, full bridge inverter with R and L load, Importance of PWM technique for voltage control.

Induction motor- Starting, Characteristic and speed control, AC drive requirements.

Applications: HF induction heating, , ON- line and OFF line UPS, Power Management Unit (PMU), Solar Photovoltaic (SPV) system.

List of Practicals:

1. DC I-V of Power MOSFET.
2. Performance of IGBT.
3. Single phase Half Controlled (Semi) converter
4. Single phase Fully Controlled (Full) converter
5. AC to AC Converter.
6. Single phase Bridge-inverter
7. MOSFET based PWM step down Chopper
8. Step up Chopper
9. Power electronic conversion system (AC-DC/ DC-DC), with suitable load.
10. Power electronic conversion system (DC-AC/AC-AC), with suitable load.
11. Study of SMPS
12. Study of UPS

List of Course Projects:

1. Single phase Power Control (e.g. Fan speed regulator)
2. Switching/triggering circuit for a power device (SCR / power BJT / power MOSFET / IGBT)
3. PWM generation for device switching
4. Power Supply/Battery charger
5. Intensity control of lighting
6. Inverter
7. SMPS
8. DC motor speed control
9. Induction motor speed control
10. Emergency lighting system
11. Power Management Unit (PMU)

List of Course Seminar Topics:

1. GaN Power Devices
2. Gate Drivers for Power Devices
3. Heat Sink Design
4. SiC Power Devices
5. IGBT based Rectifiers
6. Power Factor of Converter Systems
7. Converter Suitability for Applications
8. Sensing of Power Parameters
9. Simulation Softwares in power system design Harmonic Control in Inverters

List of Course Group Discussion Topics:

1. GaN versus SiC Power Devices
2. SCR Rectifiers versus IGBT Rectifiers
3. Protection for AC/DC Drives
4. Power Electronics Systems and Control in Electric vehicle
5. Power Quality
6. Power Management Unit
7. Solar PV System
8. Renewable Energy
9. Power Electronics in eMobility Modern Control Techniques for Converters

List of Home Assignments:**Case Study:**

1. Simulation Software Tool for Power System Design
2. Motor Control in Robotics
3. BLDC Motors
4. Battery Management Systems
5. Buck-Boost Converters

Surveys:

1. Power electronics in Space Applications
2. Power Electronics in Telecommunication
3. Generations of Power Devices
4. Filters in Power Circuits
5. Magnetics in Power Systems

Design:

1. Design of Controlled Converter System
2. Design of Inverter System
3. Design of UPS
4. Design of Converter driven DC Drive
5. Design of Inverter driven AC Drive

Blog:

1. Growth in Power demand
2. Latest Control technology of Power Systems
3. Power Regeneration Electric Traction
4. Power Systems in Self-driving Vehicles
5. Power Applications in Domestic Uses

Assessment Scheme:

Mid Semester Examination - 10 Marks

Presentation - 15 Marks

Laboratory - 10 Marks

Course Project - 10 Marks

Home Assignment - 10 Marks

Group Discussion - 15 Marks

End Semester Examination - 10 Marks

Comprehensive Viva Voce - 20 Marks

Text Books:

1. M D Singh & K B Khanchandani, "Power Electronics", 2nd Edition, Tata McGraw Hill.
2. M. H. Rashid, "Power Electronics: Circuits, Devices, and Application", 2nd Edition, Prentice Hall (I).
3. B L Theraja & A K Theraja, "A Text Book of Electrical Technology - AC & DC Machines", Volume II, S. Chand.

Reference Books:

1. Ned Mohan, Tore Undeland, Williams Robbins, "Power Electronics: Converters, Applications, and Design", 2nd Edition, John Wiley & Sons.
2. P. C. Sen, "MODERN POWER ELECTRONICS", S Chand & Co., New Delhi.

Moocs Links and additional reading material:

<https://nptel.ac.in/courses>

<https://www.coursera.org/specializations/power-electronics>

Course Outcomes:

Upon completion of the course, the student will be able to –

1. Identify power device from the structure.
2. List the differences between uncontrolled and controlled DC converters.
3. Draw output voltage waveform of AC converters.
4. Differentiate between linear and switched mode power supplies.
5. Calculate duty cycle of PWM waveform.
6. Select power converters for real life applications.

Future Courses Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	0	0	0	0	1	0	1	0	2	2	2
2	3	3	2	0	2	0	0	1	1	1	0	2	1	3
3	3	3	2	0	0	0	0	1	1	1	0	2	1	3
4	3	3	2	0	2	0	0	1	1	1	0	2	1	3
5	3	3	2	0	0	0	0	1	1	1	0	2	1	3
6	3	2	2	0	0	0	0	1	0	1	0	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO Attainment Levels:

CO1:- Level 3

CO2:- Level 2

CO3:- Level 5

CO4:- Level 4

CO5:- Level 3

CO6:- Level 2

Future Courses Mapping:

Upon completion of this course, student can take following courses –

1. Advanced Power Electronics
2. Power Systems
3. Renewable Energy
4. High Power Devices
5. Electric Vehicles/ Hybrid Vehicles
6. Electrical Machines and Drives
7. Power Control Systems

Job Mapping:

Job opportunities that one can get after learning this course

Upon completion of this course, student will be able to –

1. Join an industry which is into Automation, Robotics, Control Panel Designs, eMobility, EV Sector, Embedded Control of Power with state-of-art technology, Energy Management Services, Design of Power Converters in Space Applications etc.
2. Join Govt sectors/ Services in the areas of Power Generation, Utilization, Renewable Energy Development, Space applications
3. Become an entrepreneur in the area of Solar Systems, Energy Management Services, Power Control Units, Drives and Drives Control etc.

ET3279: ENGINEERING DESIGN AND INNOVATIONS-

Course Prerequisites:

Basic Electronics, Physics, Engineering Mathematics, Statistics, Programming Languages

Course Objectives:

1. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a group to develop team skills and learn professionalism.

Credits: 6 Teaching Scheme: Lab 2 Hours/Week

Course Relevance:

Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. Students can be evaluated for higher order skills of Blooms taxonomy like 'analyze, design and apply'. This course is capable of imparting hands on experience and self-learning to the students which will help them throughout their career. This is a step ahead in line with national policy of Atmanirbhar Bharat.

Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. This course is designed to encourage and ensure application of technology for solving real world problems using an interdisciplinary approach.

Students need to plan their work in following steps:

9. Formation of project group comprising of 4-5 students. Multidisciplinary groups are allowed
10. A supervisor/mentor teacher assigned to individual groups.
11. Carrying out literature survey
12. Finalization of problem statement
13. Planning the project execution
14. Execution of project and testing
15. Writing a report
16. Publication in the form of research paper/patent/copyright as found suitable by supervisor/mentor

Teacher's Role in PCL:

1. Teacher is not the source of solutions rather he will they act as the facilitator and mentor.
2. To utilize the principles of problems solving, critical thinking and metacognitive skills of the students.
3. To aware the group about time management.
4. Commitment to devote the time to solve student's technical problems and interested in helping students to empower them better.

Student's Role in PCL:

1. Students must have ability to initiate the task/idea they should not be mere imitators.
2. They must learn to think.
3. Students working in PCL must be responsible for their own learning.
4. Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.
5. Students in PCL are actively constructing their knowledge and understanding of the situation in groups.
6. Students in PCL are expected to work in groups.
7. They must develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

Core Technology domains identified for E&TC Engg are as below. However, this list can be extended as per the need of project and multidisciplinary approach

- 1) VLSI Design
- 2) Embedded Systems
- 3) Signal Processing
- 4) Communication
- 5) Machine learning

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

MOOCs Links and additional reading material:

www.nptelvideos.in
<https://worldwide.espacenet.com/>

Course Outcomes:

1. Review the literature to formulate problem statement to solve real world problems.
2. Apply knowledge of technology and modern tools to design solution considering sustainability and environmental issues.
3. Manage project ethically as team member/ lead.
4. Demonstrate effectively technical report/ research paper/ prototype/patent.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	1	0	0	3	1	3	0	2	2	2
2	3	3	3	3	3	3	3	2	1	2	0	2	3	3
3	0	1	1	1	0	2	0	3	3	3	3	2	0	0
4	3	1	1	1	0	0	0	3	1	3	3	2	1	0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels:

CO1: - Level 3
CO2: - Level 4
CO3: - Level 3
CO4: - Level 4

ET3282: DESIGN THINKING-5**Credits: 1****Teaching Scheme Tut: 1 Hour/Week****Course Objectives:**

To provide ecosystem for students and faculty for paper publication and patent filing

Contents:

Structure of The paper
 Journal List (Top 50 Journals)
 Selection of the journal
 Use of various online journal selection tools
 Plagiarism checking
 Improving contents of the paper
 Patent drafting
 Patent search
 Filing of patent
 Writing answers to reviewer questions
 Modification in manuscript
 Checking of publication draft

Suggest an assessment Scheme:

Publication of paper or patent

Course Outcomes:

On completion of the course, learner will be able to—

CO1: Understand the importance of doing Research
 CO2: Interpret and distinguish different fundamental terms related to Research
 CO3: Apply the methodology of doing research and mode of its publication
 CO4: Write a Research Paper based on project work
 CO5: Understand Intellectual property rights
 CO6: Use the concepts of Ethics in Research
 CO7: Understand the Entrepreneurship and Business Planning

CO- PO Mapping

	1	2	3	4	5	6	7	8	9	10	11	12	PS O1	PS O2
CO 1	1	1	1	1	1	0	0	0	0	0	0	1	2	2
CO 2	1	1	1	1	1	0	0	0	0	0	0	1	0	1

CO 3	2	2	3	3	2	2	1	2	2	3	0	1	2	1
CO 4	3	3	3	3	3	2	1	2	2	3	1	1	0	0
CO 5	1	1	1	1	1	0	0	0	0	0	0	1	0	1
CO 6	2	2	2	2	2	2	1	3	2	3	3	1	0	1
CO 7	1	1	1	1	1	0	0	0	0	0	0	1	0	2

CO Attainment levels

CO1	CO2	CO3	CO4	CO5	CO6	CO7
2	2	3	5	2	3	2

SH3001: REASONING AND APTITUDE DEVELOPMENT

Unit 1: English Language

Familiarity with English Language, Ability to understand written text, spoken word and effective communication through written documents; Coverage of vocabulary to cope up with general and specific terminology, syntax and sentence structure, prevention of incorrect use leading to distortion in communication; synonyms, antonyms and contextual vocabulary, Grammar – Error identification, sentence improvement and construction, Reading Comprehension

Unit 2: Logical Ability

Objective interpretation of things, ability to perceive and interpret trends to make generalizations; ability to analyze assumptions behind an argument or statement; Deductive reasoning: Assessment of ability to synthesize information and derive conclusions - Coding deduction logic, Data Sufficiency, Directional Sense, Logical word sequence, Objective reasoning, Selection and decision tables, puzzles; Inductive reasoning: Assessment of ability to learn by example, imitation or by trial – Analogy pattern recognition, Classification pattern recognition, Coding pattern recognition, Number series pattern recognition; Abductive reasoning: Critical thinking ability of seeing through logical weak links or loopholes in an argument or a group of statements; Critical reasoning: assessment of ability to think through and analyze logical arguments, assessment of ability to use logical constructs to offer reasoning in unfamiliar situations; Information Gathering and synthesis: Ability of locating information, information ordering, rule based selection and data interpretation, order and classify data, interpret graphs, charts, tables and make rule based deductions. Application of these approaches for using visual, numerical and textual data from single or multiple sources

Unit 3: Quantitative Ability

Basic numbers – decimals and fractions, factorization, divisibility: HCF, LCM, Odd, even, prime and rational numbers. Application of algebra to real world, direct and inverse proportion, common applications – Speed-time -distance, Profit-loss, percentage, age relations, mixtures, other miscellaneous quantitative combination, exponentials and logarithms, permutations and combinations, probability. Spatial reasoning: Inductive – Missing portions, Sequence and series; Deductive analysis.

Reference Books –

- 1: "English Grammar in Use" by Raymond Murphy, Cambridge University Press.
- 2: "Word Power Made Easy" by Norman Lewis, Goyal Publishers & Distributors.
- 3: "Objective General English" by S.P. Bakshi, Arihant Publications.
- 4: "English for Competitive Examinations" by K. Sinha, S. Chand Publishing.
- 5: "Essential English Grammar" by Philip Gucker, Wiley.
- 6: "English Idioms and Phrasal Verbs" by M.A. Yadav, Vikas Publishing House.
- 7: "The Oxford English Grammar" by Sidney Greenbaum, Oxford University Press.
- 8: "A Modern Approach to Verbal & Non-Verbal Reasoning" by R.S. Aggarwal, S. Chand Publishing, ISBN: 978-8121903409.
- 9: "Logical Reasoning and Data Interpretation for the CAT" by Nishit K. Sinha, Pearson India, ISBN: 978-8131709117.

- 10: "Logical Reasoning and Data Interpretation for the CAT" by Arun Sharma, McGraw Hill Education, ISBN: 978-0070709642.
- 11: "A New Approach to Reasoning Verbal and Non-Verbal" by B.S. Sijwali & Indu Sijwali, Arihant Publications, ISBN: 978-9311124692.
- 12: "Quantitative Aptitude for Competitive Examinations" by R.S. Aggarwal, S. Chand Publishing, ISBN: 978-8121900637.
- 13: "How to Prepare for Quantitative Aptitude for the CAT" by Arun Sharma, McGraw Hill Education, ISBN: 978-0070709642.
- 14: "The Pearson Guide to Quantitative Aptitude for Competitive Examination" by Pearson, Pearson India, ISBN: 978-8131709117.
- 15: "Quantitative Aptitude for Competitive Examinations" by Abhijit Guha, Tata McGraw Hill Education, ISBN: 978-0070666653.
- 16: "Data Interpretation & Data Sufficiency" by R.S. Aggarwal, S. Chand Publishing ISBN: 978-8121903515.
- 17: "Quantitative Aptitude for Competitive Examinations" by S. Chand, S. Chand Publishing, ISBN: 978-8121903423.

Course Outcomes –

- 1: Upon completion of the course, the student will be able to –
- 2: Improve the reading, writing and verbal skills, and enhance comprehension and articulation abilities
- 3: Develop logical reasoning abilities, enabling them to make sound decisions in problem-solving scenarios
- 4: Develop mathematical aptitude as well as data interpretation abilities and use them in test cases and real-world problems
- 5: Learn to apply approaches for optimum time-management, prioritization maximizing the accuracy
- 6: Learn data interpretation, apply mathematical skills to draw accurate conclusions
- 7: Apply their knowledge of English, reasoning and quantitative skills for planning, critical thinking and real-world problems

FF No. : 654

MD4206: FINANCIAL MANAGEMENT AND COSTING

Course Prerequisites:

Basic concepts of cost, profit, loss, debit and credit.

Course Objectives:

Students will be able to:

1. Understand, analyze and interpret financial statements
2. Understand and concept of financial accounting for analysis of financial statements of a business.
3. Develop an ability of decision making about investments.

Credits: 2

Teaching Scheme Theory: 2 Hours/Week

Course Relevance: Basic knowledge of Finance for working in a industry

SECTION-1

- 1. Financial Statement Analysis**- Nature and Scope of Finance Function; Financial goal profit vs. wealth, Maximization; Scope and Functions of Financial Management, Financial Planning and Forecasting. Budgets & Budgetary Control: Types of Budget, Preparation of Budgets: Operational & Financial Budgets, Financing and Dividend decisions. Types of accounts, bookkeeping, Profit and Loss Account and Balance Sheet, Cash Flow Statement
- 2. Capital Budgeting and ratio Analysis** -Ratio Analysis Classification, Ratio Analysis and its limitations. Types of Ratios, Activity Turnover, Profitability, Liquidity, etc., B: Common Size Statement, Index Statement, Capital Budgeting - Nature of Investment decisions; Investment evaluation criteria - Non-DCF & DCF Techniques, PBP, Discounted PBP, PI, ARR, Annual Worth
- 3. Working Capital Management** - Meaning, significance and types of working capital; calculating operating cycle period and estimation of working capital requirements; sources of working capital, NPV and IRR comparison; Capital rationing. Various committee reports on bank finance; Dimensions of working capital management.

SECTION-II

4. Introduction to concept of Cost and Overheads - Cost, Cost Centre, Cost Unit, Elements of Cost: Material Cost. Different methods of pricing of issue of materials Labour Cost: Direct & Indirect cost, Different methods, Direct Expenses: Constituents and Significance, Prime Cost, Classification: Production, Office & Administration, Selling & Distribution. Treatment of Overheads: Collection ,Primary and Secondary Distribution and Absorption of Overheads Machine, Labour hour rate, Under/Over Absorption of Overheads, Preparation of Cost Sheet

5. Costing Methods - Job Costing, Unit Costing, Contract Costing, Process Costing, Activity Based Costing Simple numerical on various methods of costing to enable ascertains cost of product. Standard costing: Concept, Standard Cost, Standard costing. Calculation of Variance Numerical on calculation of variances, Variance – Variance Analysis

6. Marginal Costing and Break Even Analysis - Fixed & Variable (Marginal) Cost, Marginal Cost. Applications of Marginal Costing in Decision-making: Product Mix, Profit Planning, Make or Buy Decisions. Limiting Factor, Cost Volume Profit Analysis, Concept of Break-Even, P/V Ratio and Margin of Safety

List of Tutorials: (Any Three)

1. Capital financing
2. Working capital finance
3. Preparation of Journal entries, Ledgers 4. Profit and Loss Account and Balance Sheet 5. Ratio Analysis
6. Investment decisions
7. Product Costing
9. Service Costing.
10. Process Costing

List of Practicals: (Any Six)

1. Case study on sources of capital and working capital
2. Case study on assessment of working capital
3. Studying and understanding Financial Statements - Profit and Loss
4. Studying and understanding Financial Statements - Balance sheet
5. Studying and understanding various financial ratios used in practice
6. Studying and understanding various financial ratios for decision making
7. Case study on Analysis of published results of an organisation – Manufacturing
8. Case study on Analysis of published results of an organisation – Service industry
9. Prepare a cost sheet to estimate the cost of any product
10. Prepare a cost sheet any process
11. Case study on use Marginal Costing to determine Break Even Point and profitability
12. Case study on use Marginal Costing to determine profitability

List of Projects:

1. Budgeting including sources of capital financing
2. Budgeting including sources of working capital finance
3. Preparation of Journal entries, Ledgers
4. Preparation Profit and Loss Account and Balance Sheet
5. Preparation of Balance Sheet
6. Ratio Analysis based on real life data from project on Profit and loss and Balance sheet
7. Compare Analysis of published results of organisations to enable investment decision
8. Apply Product Costing to estimate cost of any process used in practice
9. Apply Service Costing to estimate cost of any process used in practice
10. Apply Process Costing to estimate cost of any process used in practice
11. Apply Standard Costing to estimate cost of any process used in practice
12. Apply Marginal Costing to determine Break Even Point and profitability

List of Course Seminar Topics:

1. Sources of Capital Financing
2. Working Capital Management
3. Profit and Loss Account
4. Balance Sheet
5. Turnover and Ratios
6. Taxation
7. Product Costing
8. Service Costing
9. Process Costing
10. Investment Decisions

List of Course Group Discussion Topics:

1. Sources of Capital Financing - Bank or Investors.
2. Working Capital Management - Which is better - Less or More?
3. Profit and Loss Account
4. Balance Sheet - Effect on share prices.
5. Turnover and Ratios - which should be focused on?
6. Taxation - Fair or Unfair in India
7. Product Costing - does it drive Profits or Markets?
8. Service Costing - Quality or Cost?
9. Process Costing - Automation or Manual Labour?
10. Investment Decisions - Guts or Statistics?

Text Books:

1. Prasanna Chandra, Financial Management – Theory and Practice, Edition 8, 2011, Tata McGraw Hill Education,
2. B. K. Bhar, Cost Accounting— Methods and Problems, Academic Publishers, 1980
3. M.Y. Khan and P K Jain, Financial Management: Text, Problems and Cases, Tata McGraw Hill Education

Amitabha Mukherjee and Mohammed Hani, Modern Accountancy, Edition 2, 2002, Tata McGraw Hill Education

Reference Books:

1. Paresh P. Shah, Financial Management, Reprint No. 2 2011, Biztantra, New Delhi,
2. S. N. Maheshwari, Introduction to Accountancy, Edition 11, 2013, Vikas Publishing House

M. Y. Khan, P. K. Jain, Management Accounting –Text, Problems, Cases, Edition No. Tata McGraw Hill Publishers, 2013

Course Outcomes:

- 1.Understand and analyze financial statements and budgeting, interpret accounting ratios
- 2.Understand the concepts of Capital Budgeting and Working Capital management
- 3.Understand the mechanics of financial accounting for preparation of financial statements to ascertain the performance and financial position of a business
4. Classify, apply different types of costs and overheads to ascertain costs of a product/ process
5. Apply costing methods as per the suitability for various production processes and services.
6. Develop decision making of optimum product mix, profit planning, make or buy decisions

MD4203: BUSINESS PROPOSAL WRITING**Credits: 2****Teaching Scheme** Theory: 2 Hours/Week

SECTION-1	
Introduction The world of B2B Businesses, Pre-Scale Roles and Responsibilities, End to end bid management Process including costing.	
Focus on Customer Compliance, Responsiveness, Client Analysis and Competitive Intelligence, Strategies and win themes, Features, Benefits and Discriminators, Teaming/sub-contracting	
SECTION-2	
Manage Processes Proposal development cycle, Business approvals, and reviews, lessons learned Elements of persuasive writing Assertive writing, Headings, graphics and action captions, Page and document design, and style guides.	
Textbooks: <ol style="list-style-type: none">1. Tom Sant, Persuasive Business Proposal, AMACOM; 3rd edition2. John Care and Aron Bohlig, Mastering Technical Sale- The Sales Engineer's Handbook, Artech House; 3rd ed. Edition.3. Neil Cobb and Charlie Divine, Writing Business Bids and Proposal for Dummies, For Dummies; 1st edition, 2016.4. Larry Newman, The Shipley Proposal Guide 4.0, Shipley Associates; 4th Edition, 2011.	
Course Outcomes <ol style="list-style-type: none">1. To understand basic bid and proposal management terminologies.2. They will be able to conceptualize the entire process of bid and proposal management.3. Know the techniques and tools for customer analysis and competitive intelligence.	

4.	Create business proposals with basic building blocks.											
5.	Can create customer-centric theme statements.											
6.	Present a business proposal and defend it.											

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	0	0	0	0	0	0	0	0	0	0	2	0	0	0
2	0	0	0	0	0	0	0	0	0	0	2	0	0	0
3	0	0	2	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	2	0	0	0	0	3	0	0	0	0	0
5	0	0	0	0	0	0	0	0	3	0	0	0	0	0
6	0	0	0	0	0	0	0	0	3	0	0	0	0	0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO Attainment Level:

CO1: Level 3

CO2: Level 3

CO3: Level 3

CO4: Level 3

CO5: Level 3

CO6: Level 3

MD4228:IBM Full Stack Software Developer

Prerequisites

1. **Basic Programming Knowledge:** Familiarity with any programming language (e.g., Python, JavaScript).
2. **HTML/CSS Basics:** Basic understanding of web page creation using HTML and CSS.
3. **Problem-Solving Skills:** Ability to approach and solve coding challenges.
4. **Version Control Knowledge:** Familiarity with Git is helpful but not mandatory.

Course Description

The **IBM Full Stack Software Developer** course equips students with skills in both front-end and back-end development. It covers essential technologies for full-stack development, including HTML, CSS, JavaScript (React.js), Node.js, Express.js, databases (SQL & NoSQL), DevOps tools (Docker, Kubernetes), and cloud computing.

Students will gain practical experience in building and deploying web applications and learn industry-standard practices in software development.

Professional Certificate - 15 course series

- 1: Introduction to Software Engineering (14 hours)
- 2: Introduction to Cloud Computing (12 hours)
- 3: Introduction to HTML, CSS, & JavaScript (10 hours)
- 4: Getting Started with Git and GitHub (10 hours)
- 5: Developing Front-End Apps with React (14 hours)
- 6: Developing Back-End Apps with Node.js and Express (13 hours)
- 7: Python for Data Science, AI & Development (25 hours)
- 8: Developing AI Applications with Python and Flask (11 hours)
- 9: Django Application Development with SQL and Databases (14 hours)
- 10: Introduction to Containers with Docker, Kubernetes & OpenShift (17 hours)
- 11: Application Development using Microservices and Serverless (14 hours)
- 12: Full Stack Application Development Capstone Project (16 hours)
- 13: Full Stack Software Developer Assessment (6 hours)
- 14: Generative AI: Elevate your Software Development Career (17 hours)
- 15: Software Developer Career Guide and Interview Preparation (11 hours)

Link : <https://www.coursera.org/professional-certificates/ibm-full-stack-cloud-developer?action=enroll#courses>

MD4229:Meta Back-End Developer

Prerequisite:

Students should have a foundational understanding of programming concepts and some experience with web development using technologies like HTML, CSS, and JavaScript. Familiarity with object-oriented programming and version control is also recommended.

Course Description:

The **Meta Back-End Developer** program provides comprehensive training in back-end development, covering topics such as databases, Python programming, APIs, Django, version control, and cloud-based containerization. Students will learn to build scalable and secure back-end systems, apply microservices and serverless architectures, and gain proficiency in modern DevOps practices.

List of Courses:

1. Introduction to Back-End Development (**18 hours**)
2. Programming in Python (**44 hours**)
3. Version Control (**13 hours**)
4. Introduction to Databases for Back-End Development (**27 hours**)
5. Django Web Framework (**45 hours**)
6. APIs (**20 hours**)
7. The Full Stack (**24 hours**)
8. Back-End Developer Capstone (**20 hours**)
9. Coding Interview Preparation (**11 hours**)

Course Link: <https://www.coursera.org/professional-certificates/meta-back-end-developer#courses>

MD4230:IBM Back-End Developer

Prerequisite:

Students should have basic knowledge of programming languages and foundational skills in web development, including HTML, CSS, and JavaScript. Familiarity with basic software development concepts will be beneficial.

Course Description:

The **IBM Back-End Developer** course offers comprehensive training in back-end development, covering essential topics such as Python programming, databases, Django web framework, API development, and cloud computing concepts. This course is designed to equip students with the skills required to build robust and scalable back-end systems, including the use of containers, microservices, and serverless architectures.

List of Courses:

1. Introduction to Back-End Development (**18 hours**)
2. Programming in Python (**44 hours**)
3. Version Control (**13 hours**)
4. Introduction to Databases for Back-End Development (**27 hours**)
5. Django Web Framework (**45 hours**)
6. APIs (**20 hours**)
7. The Full Stack (**24 hours**)
8. Back-End Developer Capstone (**20 hours**)
9. Coding Interview Preparation (**11 hours**)

Link: <https://www.coursera.org/professional-certificates/ibm-backend-development#courses>

MD4233:Microsoft Power BI Data Analyst

Prerequisites

- 1: **Basic Data Analysis Skills:** Familiarity with Excel, including charts, tables, and basic formulas.
- 2: **Understanding of Databases:** Basic knowledge of databases and data structures.
- 3: **Problem-Solving Skills.**

Course Description

The **Microsoft Power BI Data Analyst** course teaches students how to use Power BI, a business intelligence tool, to create interactive dashboards, visualize data, and generate insights. It covers the entire process, from connecting data sources to cleaning and transforming data, and building reports to share with stakeholders.

Certificate Courses

1. Preparing Data for Analysis with Microsoft Excel
Duration: 19 hours
2. Harnessing the Power of Data with Power BI
Duration: 16 hours
3. Extract, Transform, and Load (ETL) Data in Power BI
Duration: 20 hours
4. Data Modeling in Power BI
Duration: 24 hours
5. Data Analysis and Visualization with Power BI
Duration: 28 hours
6. Creative Designing in Power BI
Duration: 20 hours
7. Deploy and Maintain Power BI Assets and Capstone Project
Duration: 24 hours
8. Microsoft PL-300 Exam Preparation and Practice
Duration: Self-paced

MD4234:Tableau Business Intelligence Analyst

Prerequisites

- 1: **Basic Data Analysis Skills:** Familiarity with Excel or Google Sheets for data manipulation.
- 2: **Understanding of Databases:** Basic knowledge of relational databases and data structures.

Course Description

The **Tableau Business Intelligence Analyst** course provides a comprehensive understanding of Tableau, a leading data visualization tool used in business intelligence. The course equips students with the skills to analyze data, create interactive dashboards, and share insights with stakeholders, empowering data-driven decision-making in businesses.

Certificate Courses

- 1: **Introduction to Business Analytics**
Duration: 14 hours
- 2: **Business Analysis Process**
Duration: 22 hours
- 3: **Data Ecosystem**
Duration: 14 hours
- 4: **Introduction to Tableau**
Duration: 19 hours
- 5: **Data Visualization with Tableau**
Duration: 26 hours
- 6: **Advanced Data Visualization with Tableau**
Duration: 21 hours
- 7: **Data Analysis with Tableau**
Duration: 26 hours
- 8: **Communicating Data Insights with Tableau**

4237:IBM Cybersecurity Analyst

Prerequisites

- 1: **Basic IT Knowledge:** Understanding of basic IT concepts such as networking, databases, and operating systems.
- 2: **Familiarity with Computer Systems:** Basic knowledge of how computer systems work, including hardware and software components.
- 3: **Problem-Solving Skills.**

Course Description

The **IBM Cybersecurity Analyst** course is designed to provide students with the foundational skills required for a career in cybersecurity. Students will learn how to detect, analyze, and respond to security incidents, as well as how to apply best practices to safeguard data and systems from cyber threats.

Certificate Courses

1. **Introduction to Cybersecurity Careers** (Duration: 7 hours)
2. **Introduction to Cybersecurity Essentials** (Duration: 12 hours)
3. **Introduction to Cybersecurity Tools & Cyberattacks**, Duration: 11 hours
4. **Operating Systems: Overview, Administration, and Security**, Duration: 17 hours
5. **Computer Networks and Network Security**, Duration: 14 hours
6. **Database Essentials and Vulnerabilities**, Duration: 14 hours
7. **Cybersecurity Architecture**, Duration: 12 hours
8. **Cybersecurity Compliance Framework, Standards & Regulations**
Duration: 11 hours
9. **Penetration Testing, Incident Response, and Forensics**, Duration: 17 hours
10. **Cyber Threat Intelligence**, Duration: 27 hours
11. **Cybersecurity Capstone: Breach Response Case Studies**
Duration: 13 hours
12. **IBM Cybersecurity Analyst Assessment**
Duration: 4 hours
13. **Generative AI: Boost Your Cybersecurity Career**
Duration: 9 hours
14. **Cybersecurity Job Search, Resume, and Interview Prep**

MD4238:Microsoft Cybersecurity Analyst

Prerequisites

- 1: **Basic IT Knowledge:** Understanding of fundamental IT concepts like networking, operating systems, and databases.
- 2: **Familiarity with Security Concepts:** Basic knowledge of cybersecurity concepts such as firewalls, encryption, and malware.
- 3: **Problem-Solving Skills.**

Course Description

The **Microsoft Cybersecurity Analyst** course is designed to equip students with the essential skills needed for cybersecurity roles. Students will learn how to protect systems, networks, and data through practical techniques and industry-standard tools. This course prepares students for roles such as Security Operations Center (SOC) Analyst, Network Security Analyst, and Penetration Tester.

Certificate Courses

1. Introduction to Computers
2. and Operating Systems and Security (**15 hours**)
3. Introduction to Networking and Cloud Computing (**25 hours**)
4. Cybersecurity Threat Vectors and Mitigation (**20 hours**)
5. Cybersecurity Identity and Access Solutions using Azure AD (**20 hours**)
6. Cybersecurity Solutions and Microsoft Defender (**20 hours**)
7. Cybersecurity Tools and Technologies (**20 hours**)
8. Cybersecurity Management and Compliance (**20 hours**)
9. Advanced Cybersecurity Concepts and Capstone Project (**20 hours**)
10. Microsoft SC-900 Exam Preparation and Practice

MD4239:Google Cybersecurity

Prerequisites

- **Basic IT Knowledge:** Familiarity with fundamental IT concepts such as networks, databases, and operating systems.
- **Understanding of Security Concepts:** Basic knowledge of cybersecurity principles, like firewalls, malware, and encryption.
- **Problem-Solving Skills.**

Course Description

The **Google Cybersecurity** course prepares students for a career in cybersecurity, equipping them with the practical skills needed to defend networks and systems from cyber threats. This course provides training on key cybersecurity concepts, tools, and Google-specific solutions for threat management and mitigation.

Certificate Courses

1. **Foundations of Cybersecurity** (14 hours)
2. **Play It Safe: Manage Security Risks** (11 hours)
3. **Connect and Protect: Networks and Network Security** (14 hours)
4. **Tools of the Trade: Linux and SQL** (27 hours)
5. **Assets, Threats, and Vulnerabilities** (26 hours)
6. **Sound the Alarm: Detection and Response** (24 hours)
7. **Automate Cybersecurity Tasks with Python** (30 hours)
8. **Put It to Work: Prepare for Cybersecurity Jobs** (21 hours)

MD4240:Google Data Analytics

Prerequisites

1. **Basic Computer Skills:** Familiarity with spreadsheets and basic data manipulation.
2. **Problem-Solving Skills:** Ability to approach data-related problems analytically.

Course Description

The **Google Data Analytics** course is designed to equip students with the essential skills required for a career in data analytics. It covers the complete data analysis process, from data cleaning to data visualization and presenting insights. This program prepares students for entry-level roles in data analytics and data-driven decision-making.

Certificate Courses

1. Foundations: Data, Data, Everywhere (**18 hours**)
2. Ask Questions to Make Data-Driven Decisions (**20 hours**)
3. Prepare Data for Exploration (**24 hours**)
4. Process Data from Dirty to Clean (**26 hours**)
5. Analyze Data to Answer Questions (**32 hours**)
6. Share Data Through the Art of Visualization (**25 hours**)
7. Data Analysis with R Programming (**34 hours**)
8. Google Data Analytics Capstone: Complete a Case Study

MD4243:IBM Data Engineering

Prerequisites

- **Basic Programming Knowledge:** Familiarity with Python, SQL, or other programming languages.
- **Understanding of Databases:** Basic knowledge of relational and non-relational databases.

Course Description

The **IBM Data Engineering** course is designed to provide students with the skills needed to become proficient in data engineering. This course covers data architecture, data pipelines, cloud integration, and more, equipping students to manage, analyze, and transform big data for businesses. It prepares students for roles like Data Engineer and Database Administrator.

Certification & Courses

Upon completing the program, students will earn a **Professional Certificate** in Data Engineering. The course includes the following modules:

- 1: **Introduction to Databases** (27 hours)
- 2: **Version Control** (13 hours)
- 3: **Database Structures and Management with MySQL** (32 hours)
- 4: **Advanced MySQL Topics** (18 hours)
- 5: **Programming in Python** (44 hours)
- 6: **Database Clients** (40 hours)
- 7: **Advanced Data Modeling** (18 hours)
- 8: **Database Engineer Capstone** (18 hours)
- 9: **Coding Interview Preparation** (11 hours)

MD4245:IBM Data Science

Prerequisites

1. Basic Math and Statistics Knowledge:
2. Basic Programming Skills

Course Description

The **IBM Data Science Professional Certificate** is designed to provide students with a strong foundation in data science, covering data analysis, machine learning, Python programming, and practical applications using real-world datasets. It prepares students for entry-level roles in data science and analytics, equipping them with the skills needed to analyze data, create models, and derive insights.

Certification & Courses

Upon completion, students will earn the **IBM Data Science Professional Certificate**. The program consists of the following courses:

1. What is Data Science? **(11 hours)**
2. Tools for Data Science **(18 hours)**
3. Data Science Methodology **(6 hours)**
4. Python for Data Science, AI & Development **(25 hours)**
5. Python Project for Data Science **(8 hours)**
6. Databases and SQL for Data Science with Python **(20 hours)**
7. Data Analysis with Python **(15 hours)**
8. Data Visualization with Python **(20 hours)**
9. Machine Learning with Python **(13 hours)**
10. Applied Data Science Capstone **(13 hours)**
11. Generative AI: Elevate Your Data Science Career **(12 hours)**
12. Data Scientist Career Guide and Interview Preparation **(9 hours)**

MD4246:Fractal Data Science

Prerequisites

- 1: Basic Math and Statistics Knowledge
- 2: Programming Knowledge

Course Description

The **Fractal Data Science** course is designed to provide a comprehensive understanding of data science, covering topics such as data analysis, machine learning, data visualization, and more. It prepares students for roles in data science by teaching them to analyze and model data using industry-standard tools and techniques.

Certificate Courses

1. Structured Approach to Problem Solving (**15 hours**)
2. Data Analysis Using SQL (**18 hours**)
3. Insights of Power BI (**14 hours**)
4. Python for Data Science (**39 hours**)
5. Human Decision Making and its Biases (**14 hours**)
6. Foundations of Machine Learning (**25 hours**)
7. Advanced Machine Learning Algorithms (**20 hours**)
8. Data Storytelling

MD4241:IBM Data Analyst

Prerequisites

- 1: Basic Math and Statistics Knowledge.
- 2: Familiarity with Spreadsheets.

Course Description

The **IBM Data Analyst** course is designed to equip students with the skills needed to analyze data, present insights, and make data-driven decisions. This course covers essential data analysis tools such as Excel, SQL, Python, and data visualization techniques using tools like IBM Cognos Analytics. It prepares students for roles such as Data Analyst and Business Analyst.

Professional Certificate - 11 course series

Prepare for a career in the **high-growth field of data analytics**. In this program, students will learn in-demand skills like Python, Excel, and SQL to get job-ready in as little as 4 months.

Certificate Courses

1. Introduction to Data Analytics (**10 hours**)
2. Excel Basics for Data Analysis (**11 hours**)
3. Data Visualization and Dashboards with Excel and Cognos (**15 hours**)
4. Python for Data Science, AI & Development (**25 hours**)
5. Python Project for Data Science (**8 hours**)
6. Databases and SQL for Data Science with Python (**20 hours**)
7. Data Analysis with Python (**15 hours**)
8. Data Visualization with Python (**20 hours**)
9. IBM Data Analyst Capstone Project (**18 hours**)
10. Generative AI: Enhance your Data Analytics Career (**14 hours**)
11. Data Analyst Career Guide and Interview Preparation (**10 hours**)

MD4248:IBM DevOps and Software Engineering

Prerequisites

- 1: **Basic Programming Knowledge.**
- 2: **Understanding of Software Development Life Cycle (SDLC):** Basic knowledge of SDLC, including development and testing phases.

Course Description

The **IBM DevOps and Software Engineering** course is designed to equip students with the skills needed to manage the full software development lifecycle (SDLC) through DevOps principles. This program focuses on automation, continuous integration/continuous deployment (CI/CD), containerization, and cloud infrastructure management, preparing students for roles such as DevOps Engineer and Software Engineer.

Professional Certificate - 15 course series

Certificate Courses

- 1. Introduction to DevOps (9 hours)**
- 2. Introduction to Cloud Computing (12 hours)**
- 3. Introduction to Agile Development and Scrum (11 hours)**
- 4. Introduction to Software Engineering (14 hours)**
- 5. Getting Started with Git and GitHub (10 hours)**
- 6. Hands-on Introduction to Linux Commands and Shell Scripting (14 hours)**
- 7. Python for Data Science, AI & Development (25 hours)**
- 8. Developing AI Applications with Python and Flask (11 hours)**
- 9. Introduction to Containers with Docker, Kubernetes & OpenShift (17 hours)**
- 10. Application Development using Microservices and Serverless (14 hours)**
- 11. Introduction to Test and Behavior Driven Development (19 hours)**
- 12. Continuous Integration and Continuous Delivery (CI/CD) (14 hours)**
- 13. Application Security for Developers and DevOps Professionals (17 hours)**
- 14. Monitoring and Observability for Development and DevOps (16 hours)**
- 15. DevOps Capstone Project (18 hours)**

MD4249:Google Digital Marketing and E-Commerce

Prerequisites

- 1: **Basic Computer Skills:** Familiarity with internet browsing and common applications.
- 2: **Problem-Solving Skills.**

Course Description

The **Google Digital Marketing and E-Commerce** course is designed to provide students with the skills needed to succeed in the fields of digital marketing and e-commerce. This program covers key aspects such as search engine optimization (SEO), social media marketing, email marketing, and building e-commerce stores. It prepares students for roles like Digital Marketing Specialist, E-Commerce Manager, and Social Media Manager.

Professional Certificate - 7 course series Certificate Courses

1. Foundations of Digital Marketing and E-Commerce (**18 hours**)
2. Attract and Engage Customers with Digital Marketing (**21 hours**)
3. From Likes to Leads: Interact with Customers Online (**28 hours**)
4. Think Outside the Inbox: Email Marketing (**25 hours**)
5. Assess for Success: Marketing Analytics and Measurement (**27 hours**)
6. Make the Sale: Build, Launch, and Manage E-Commerce Stores (**23 hours**)
7. Satisfaction Guaranteed: Develop Customer Loyalty Online.

MD4250:Meta Front-End Developer

Prerequisites

- 1. Basic Computer Skills:** Familiarity with web browsers and internet usage.
- 2. Problem-Solving Skills.**

Course Description

The **Meta Front-End Developer** course provides students with the skills required to become proficient in front-end development. This program focuses on the essential tools and technologies used to build interactive, responsive websites and applications. By the end of the course, students will be able to create dynamic user experiences and build websites that function well on any device. This program prepares students for roles such as Front-End Developer and Web Developer.

Certificate Courses

- 1. Introduction to Front-End Development (18 hours)**
- 2. Programming with JavaScript (42 hours)**
- 3. Version Control (13 hours)**
- 4. HTML and CSS in Depth (28 hours)**
- 5. React Basics (26 hours)**
- 6. Advanced React (26 hours)**
- 7. Principles of UX/UI Design (21 hours)**
- 8. Front-End Developer Capstone (27 hours)**
- 9. Coding Interview Preparation (11 hours)**

MD4251:IBM Front-End Developer

Prerequisites

- **Basic Computer Skills:** Familiarity with using a web browser and navigating websites.
- **Problem-Solving Skills:** Ability to think logically and solve coding-related problems.

Course Description

The **IBM Front-End Developer** course is designed to provide students with a comprehensive foundation in front-end web development. This program covers everything from the basics of HTML, CSS, and JavaScript to more advanced topics like React and responsive design. By the end of the program, students will be able to create functional, visually appealing, and responsive web applications. The course prepares students for roles such as Front-End Developer, Web Developer, and UI Developer.

Certificate Courses

1. Getting Started with Front-End and Web Development (**14 hours**)
2. Introduction to Software Engineering (**14 hours**)
3. Designing User Interfaces and Experiences (UI/UX) (**18 hours**)
4. Introduction to HTML, CSS, & JavaScript (**10 hours**)
5. Developing Websites and Front-Ends with Bootstrap (**7 hours**)
6. Getting Started with Git and GitHub (**10 hours**)
7. Developing Front-End Apps with React (**14 hours**)
8. Intermediate Web and Front-End Development (**12 hours**)
9. Get Started with Cloud Native, DevOps, Agile, and NoSQL (**13 hours**)
10. Front-End Development Capstone Project (**20 hours**)
11. Software Developer Career Guide and Interview Preparation (**11 hours**)

MD4253:Meta iOS Developer

Prerequisites

- **Basic Programming Knowledge:** Familiarity with any programming language such as Python, Java, or Swift.
- **Problem-Solving Skills.**

Course Description

The **Meta iOS Developer** course provides students with the skills necessary to design, develop, and deploy iOS applications. The course focuses on Swift programming, iOS frameworks, and Apple's development environment. By the end of the course, students will have built fully functional iOS apps, gaining the skills required for roles like iOS Developer and Mobile App Developer.

Certificate Courses

1. Introduction to iOS Mobile Application Development (**11 hours**)
2. Version Control (**13 hours**)
3. Programming Fundamentals in Swift (**26 hours**)
4. Principles of UX/UI Design (**21 hours**)
5. Create the User Interface with SwiftUI (**20 hours**)
6. Advanced Programming in Swift (**19 hours**)
7. Working with Data in iOS (**18 hours**)
8. Mobile Development and JavaScript (**45 hours**)
9. React Basics (**26 hours**)
10. React Native (**38 hours**)
11. iOS App Capstone (**16 hours**)
12. Coding Interview Preparation (**11 hours**)

MD4254:IBM IT Project Manager

Prerequisites

- **Basic IT Knowledge:** Familiarity with information technology concepts and practices.
- **Problem-Solving Skills.**

Course Description

The **IBM IT Project Manager** course is designed to equip students with the skills necessary to manage IT projects efficiently. This program covers project planning, execution, risk management, and the application of Agile and Scrum methodologies. It prepares students for roles such as IT Project Manager and Scrum Master, with a focus on managing technical teams and delivering projects on time and within budget.

Certificate Courses

1. Introduction to Project Management (**9 hours**)
2. Project Management Foundations, Initiation, and Planning (**20 hours**)
3. Project Lifecycle, Information Sharing, and Risk Management (**16 hours**)
4. Project Management Communication, Stakeholders & Leadership (**19 hours**)
5. Information Technology (IT) Fundamentals for Everyone (**18 hours**)
6. Introduction to Software Engineering (**14 hours**)
7. Introduction to Agile Development and Scrum (**11 hours**)
8. Introduction to Scrum Master Profession (**9 hours**)
9. Project Management Capstone (**18 hours**)
10. Practice Exam for CAPM Certification (**5 hours**)
11. Project Management Job Search, Resume, and Interview Prep

MD4255:Google IT Support

Prerequisites

- **Basic Computer Skills:** Familiarity with computer operations and using common software.
- **Problem-Solving Skills.**

Course Description

The **Google IT Support** course is designed to prepare students for a career in IT support, providing them with the skills needed to troubleshoot, manage, and resolve IT-related issues. It covers a wide range of topics, including computer networking, operating systems, system administration, and security. By the end of the program, students will be equipped for roles like IT Support Specialist, Systems Administrator, and Network Administrator.

Certification & Courses

Upon completion, students will earn a **Professional Certificate** in IT Support from Google. The program includes the following courses:

1. **Technical Support Fundamentals**
Duration: 14 hours
2. **The Bits and Bytes of Computer Networking**
Duration: 20 hours
3. **Operating Systems and You: Becoming a Power User**
Duration: 25 hours
4. **System Administration and IT Infrastructure Services**
Duration: 23 hours
5. **IT Security: Defense against the Digital Dark Arts**
Duration: 30 hours

MD4257:IBM Mainframe Developer

Prerequisites:

1. Basic understanding of programming concepts.
2. Familiarity with any programming language (Python, Java, or C) is helpful.
3. Knowledge of computer systems and software development lifecycle.
4. No prior mainframe knowledge is required.

Description

This professional certificate program is designed to equip learners with the necessary skills and knowledge to become proficient in IBM Mainframe Development. The course covers key concepts and technologies related to mainframe computing, including COBOL programming, JCL (Job Control Language), z/OS, database management, and more. Learners will gain hands-on experience with real-world projects and challenges, enabling them to work effectively as Mainframe Developers in enterprise environments. Upon completion, learners will have the foundational skills to understand and manage mainframe systems, which remain crucial in industries like finance, insurance, and government.

Professional Certificate - 7 course series

List of courses with their durations in parentheses:

1. Introduction to Enterprise Computing (9 hours)
2. IBM COBOL Basics (13 hours)
3. IBM COBOL Core (10 hours)
4. IBM COBOL Software Development Practices (17 hours)
5. IBM COBOL Data and File Management (16 hours)
6. IBM COBOL Basic Testing and Debugging (13 hours)
7. IBM COBOL Software Development Process (17 hours)

MD4258:Meta Marketing Analytics

Prerequisites:

1. Basic knowledge of digital marketing.
2. Familiarity with key digital marketing platforms is helpful but not required.
3. No prior experience in data analytics is required.

Description:

The Meta Marketing Analytics Professional Certificate is designed to provide learners with the skills needed to analyze data, measure the effectiveness of marketing campaigns, and make data-driven marketing decisions. This program equips learners with practical experience using key marketing analytics tools and platforms, preparing them for a career in digital marketing and analytics. Learners will explore key concepts such as data collection, data visualization, marketing strategies, and attribution modeling, with a focus on real-world applications using Meta's marketing platforms.

List of courses for the **Meta Marketing Analytics** Professional Certificate from Coursera with their durations:

1. Marketing Analytics Foundation (11 hours)
2. Introduction to Data Analytics (17 hours)
3. Data Analysis with Spreadsheets and SQL (25 hours)
4. Python Data Analytics (21 hours)
5. Statistics Foundations (21 hours)
6. Data Analytics Methods for Marketing (12 hours)
7. Marketing Analytics with Meta (13 hours)
8. Meta Marketing Science Certification Exam

MD4259:Akamai Network Engineering

Prerequisites:

- Basic understanding of computer networking and internet protocols (TCP/IP, DNS, HTTP).
- Familiarity with cloud computing and content delivery concepts.
- Prior experience with network administration or a similar technical role is helpful but not mandatory.

Description:

The Akamai Network Engineering course is designed to provide learners with comprehensive knowledge of Akamai's content delivery network (CDN) architecture, edge computing, and internet performance optimization techniques. The course covers key concepts in networking, CDN technologies, traffic management, load balancing, and security protocols to ensure efficient and secure web traffic delivery. By the end of the course, learners will gain practical experience in implementing and managing Akamai's network solutions, making them proficient in addressing the challenges of modern internet infrastructure.

List of courses for the **Akamai Network Engineering** program without the ratings:

1. Operating Systems Fundamentals (30 hours)
2. Networking Fundamentals (26 hours)
3. Managing Relational Databases (17 hours)
4. Python Scripting Fundamentals (33 hours)
5. Introduction to IT Security (22 hours)

MD4260:Google Project Management

Prerequisites:

- Basic computer literacy and familiarity with productivity tools (like Google Workspace or Microsoft Office) is helpful.

Description

The Google Project Management Professional Certificate equips learners with essential project management skills that are in high demand across various industries. The course covers project planning, execution, and management, focusing on agile methodologies, stakeholder communication, risk management, and tools like Gantt charts and project management software. This program is ideal for individuals looking to start or enhance their careers in project management without prior experience. By completing this course, learners will gain practical knowledge and hands-on experience in managing projects efficiently, preparing them for roles like Project Coordinator, Project Manager, or Scrum Master.

List of courses for the **Google Project Management** Professional Certificate with their durations:

1. Foundations of Project Management (18 hours)
2. Project Initiation: Starting a Successful Project (23 hours)
3. Project Planning: Putting It All Together (33 hours)
4. Project Execution: Running the Project (30 hours)
5. Agile Project Management (26 hours)
6. Capstone: Applying Project Management in the Real World

MD4266:SAP Technology Consultant

Prerequisites:

- Basic understanding of enterprise resource planning (ERP) concepts.
- Familiarity with IT systems and database management is recommended.

Description:

The SAP Technology Consultant Professional Certificate is designed to prepare learners for a career in SAP consultancy, focusing on the technical aspects of SAP systems. The course covers key topics like SAP architecture, SAP HANA, system configuration, integration, and cloud solutions. Learners will gain hands-on experience with SAP technologies, learning how to implement, configure, and manage enterprise systems effectively. The program prepares learners for roles in enterprise resource planning (ERP) system management, SAP consulting, and technical implementation. By the end of the course, learners will have the foundational skills to work as SAP Technology Consultants, aiding organizations in optimizing their SAP systems for business processes.

List of courses for the **SAP Technology Consultant** program with their durations:

1. SAP Professional Fundamentals (14 hours)
2. Understanding the Enterprise Systems Environment (11 hours)
3. SAP Customer Engagement and Discovery (13 hours)
4. Designing an SAP Solution (13 hours)
5. Implementing an SAP Solution (14 hours)
6. SAP Technology Consultant Hands-on Project (18 hours)
7. Becoming an SAP Professional (8 hours)

MD4267:AWS Cloud Technology Consultant

Prerequisites:

- Basic understanding of IT systems and networking.
- Familiarity with cloud computing concepts is recommended but not required.
- Knowledge of Python or any programming language is beneficial but not mandatory.

Description:

The AWS Cloud Technology Consultant Professional Certificate equips learners with the foundational skills needed to excel as cloud technology consultants specializing in Amazon Web Services (AWS). This program covers key aspects of cloud architecture, AWS workload support, DevOps, automation, and data analytics. Learners gain hands-on experience working with AWS services, developing Python-based applications, managing cloud infrastructures, and providing technical consulting. Graduates will be well-prepared for roles such as cloud consultant, AWS support technician, and cloud project manager.

Course Breakdown and Duration:

1. Introduction to Information Technology and AWS Cloud (6 hours)
2. AWS Cloud Technical Essentials (26 hours)
3. Providing Technical Support for AWS Workloads (7 hours)
4. Developing Applications in Python on AWS (9 hours)
5. Skills for Working as an AWS Cloud Consultant (10 hours)
6. DevOps on AWS and Project Management (8 hours)
7. Automation in the AWS Cloud (8 hours)
8. Data Analytics and Databases on AWS (9 hours)
9. Capstone: Following the AWS Well Architected Framework (11 hours)

MD4268:Google UX Design

Prerequisites:

- Basic computer skills are helpful.

Description:

The **Google UX Design Professional Certificate** prepares learners to become job-ready UX designers. This program provides a thorough understanding of the user experience design process, including research, wireframing, prototyping, and testing. Learners will gain hands-on experience using industry-standard tools like Figma and Adobe XD, as well as conduct user research to create effective and impactful designs. By the end of the course, learners will be able to develop intuitive, accessible, and aesthetically pleasing user interfaces, ready to launch their careers as UX designers.

Course Breakdown and Duration:

1. Foundations of User Experience (UX) Design (19 hours)
2. Start the UX Design Process: Empathize, Define, and Ideate (21 hours)
3. Build Wireframes and Low-Fidelity Prototypes (17 hours)
4. Conduct UX Research and Test Early Concepts (20 hours)
5. Create High-Fidelity Designs and Prototypes in Figma (29 hours)
6. Build Dynamic User Interfaces (UI) for Websites (22 hours)
7. Design a User Experience for Social Good & Prepare for Jobs (27 hours)

MD4244:Meta Database Engineer

Prerequisites

- **Basic Database Knowledge:** Familiarity with relational databases and SQL.
- **Programming Skills:** Understanding of at least one programming language like Python or JavaScript.
- **Problem-Solving Skills.**

Course Description

The **Meta Database Engineer** course is designed to provide students with the skills needed to design, implement, and manage large-scale databases. This course covers topics like database architecture, advanced SQL, data modeling, and database performance optimization. It prepares students for roles like Database Engineer, Data Architect, and Database Administrator.

Certification & Courses

Upon completion, students will receive a **Professional Certificate** in Database Engineering. The course includes the following modules:

1. **Introduction to Database Systems**
Duration: 14 hours
2. **SQL for Database Management**
Duration: 18 hours
3. **Advanced SQL for Data Engineers**
Duration: 22 hours
4. **Data Modeling and Database Design**
Duration: 24 hours
5. **Database Optimization and Tuning**
Duration: 20 hours
6. **NoSQL Databases**
Duration: 16 hours
7. **Cloud Databases and Distributed Systems**
Duration: 25 hours
8. **Capstone Project: Designing a Large-Scale Database**
Duration: 30 hours

ET4230: NATURAL LANGUAGE PROCESSING

Course Prerequisites:

1. Probability and statistics.
2. Linear Algebra
3. Python programming language

Course Objectives:

1. Learn fundamentals of Text processing
2. Understand the different Language Models
3. Implement POS tagging
4. Implement Text classification
5. Implement sentiment analysis
6. Implement Machine translation

Credits: 2

Teaching Scheme Theory: 2 Hours/Week

Course Relevance:

Natural Language Processing is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. The common applications of NLP involves, Google translator, Word Processors such as Microsoft, Interactive Voice Response, Personal assistant applications.

SECTION-1

Text Processing: Basics, Empirical Laws, Spelling Correction: Edit Distance, N-Gram Language Models, Basic Smoothing, POS Tagging, Hidden Markov Models for POS Tagging, Viterbi Decoding for HMM and Parameter Learning, Maximum Entropy Models.

SECTION-2

Maximum Entropy Models, Name entity recognition, Syntax, Dependency Grammars and Parsing, Semantic, text classification, sentiment analysis, Machine Translation, Question Answering.

List of Course Seminar Topics:

1. SemEval-2016 task 4: Sentiment analysis in Twitter
2. Modelling user attitudes using hierarchical sentiment-topic model
3. Multilingual dynamic topic model
4. Document-Level Text -classification Using Single-Layer Multisize Filters Convolutional Neural Network
5. Twitter Storytelling Generator Using Latent Dirichlet Allocation and Hidden Markov Model POS-TAG (Part-of-Speech Tagging)
7. Part-of-speech Tagging and Named Entity Recognition Using Improved Hidden Markov Model and Bloom Filter
8. Part of speech tagging for Twitter conversations using Conditional Random Fields model
9. A system for named entity recognition based on local grammars
10. A Maximum-Entropy Segmentation Model for Statistical Machine Translation
11. Mobile embodied conversational agent for task specific applications.

List of Course Group Discussion Topics:

1. Smoothing Technique
2. N-gram models
3. POS tagging
4. Ambiguities in NLP
5. Challenges in NLP
6. Challenges in designing Language Translators
7. Challenges in designing text classification
8. Challenges in designing sentiment analysis
9. Challenges in designing Question and Answering system
10. Challenges in designing text summarization

List of Home Assignments:

Design:

1. POS tagging using HMM
2. Build Chatbot
3. Summarization of customers reviews
4. Social media Information extraction
5. SMS spam classification

Case Study:

1. Hiring and recruitment
2. Advertising
3. Healthcare

- 4. Market intelligence
- 5. Sentiment analysis

Blog:

- 1. Social media Information extraction
- 2. Name Prediction in Multiple Languages using Recurrent Neural Networks
- 3. Text Classification using Sentiment Analysis
- 4. Image Caption Generator
- 5. gender identification in Marathi names

Surveys

- 1. POS tagging techniques
- 2. SMS and email spam classification
- 3. Categorization of sport articles
- 4. Machine translation Techniques
- 5. Name entity recognition methods

Assessment Scheme:

Mid Semester Examination - 30 Marks

Home Assignment - 10 Marks

End Semester Examination - 30 Marks

Comprehensive Viva Voce - 30 Marks

Textbooks:

- 1. Jurafsky & Martin "Speech and Language Processing" Prentice Hall, 2000
- 2. Akshar Bharati, Rajeev Sangal and Vineet Chaitanya: "Natural Language Processing: Paninian Perspective", Prentice-Hall of India, New Delhi, 1995.

Reference Books:

- 1. Steven Bird, Ewan Klein, and Edward Loper "Natural Language Processing"

MOOCS Links and additional reading material:

- 1. <https://nptel.ac.in/courses/106/105/106105158/>
- 2. <https://nptel.ac.in/courses/106/106/106106211/>

Course Outcomes: The student will be able to –

- 1. Have broad understanding of the field of natural language processing.
- 2. Get acquainted with the algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
- 3. Apply mathematical models and algorithms in applications of NLP.
- 4. Design and implementation issues in various NLP applications such as information retrieval and information extraction.

5. Demonstrate crucial ideas in linguistics (e.g., syntax, semantics, pragmatics), artificial intelligence (e.g., knowledge representation), and machine learning (e.g., deep learning) to natural language processing.

6. Identify one of the contemporary (sub) problems of natural language processing and implement, in the form of a complete computer program as a possible solution to it.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1	0	0	0	0	0	0	1	0	0	1	0
2	2	2	2	2	2	0	0	2	1	1	0	1	1	1
3	3	2	2	0	0	0	0	2	1	1	1	1	1	1
4	3	3	3	3	3	2	0	2	1	1	1	1	1	1
5	2	2	2	2	2	2	0	2	1	1	1	1	1	1
6	3	3	3	3	3	2	0	2	1	1	1	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels

1. CO1- Level 3
2. CO2- Level 3
3. CO3- Level 4
4. CO4- Level 4
5. CO5- Level 4
6. CO6- Level 5

Job Mapping:

Natural Language engineers, Data Scientist and Algorithm Architect with industries in domains Media & Entertainment, Healthcare and Finance.

ET4232: DEEP LEARNING

Course Prerequisites: Linear algebra, probability theory and statistics, Digital signal processing, Computer vision

Course Objectives:

1. To present the mathematical, statistical and computational concepts for stable representations of high-dimensional data, such as images, text
2. To introduce NN and techniques to improve network performance
3. To introduce Convolutional networks
4. To introduce Sequential models of NN
5. To build deep nets with applications to solve real world problem

Credits: 2

Teaching Scheme Theory: 2 Hours/Week

Course Relevance:

Deep learning is revolutionizing the technology and business world today. It is a subfield of machine learning concerned with algorithms to train computers to perform tasks by exposing neural networks to large amounts of data, its analysis and prediction. It is an incredibly powerful field with capacity to execute feature engineering on its own, uses multiple neural network layers to extract patterns from the data. Top applications of Deep learning involve, self-driving cars, natural language processing, robotics, finance, and healthcare.

SECTION-1

Foundations of neural networks and deep learning, Logistic regression as a neural network, different activation function, logistic regression cost function, logistic regression gradient descent, vectorizing logistic regression, forward and backward propagation, Techniques to improve neural networks: regularization and optimizations, hyperparameter tuning, batch normalization, data augmentation, deep learning frameworks, Implementation of neural network for a case study.

SECTION-2

Convolutional Neural Networks, padding, strided convolution, pooling layers, convolutional implementation of sliding windows, Applications: object classification, object detection, face verification. ResNet, inception networks, bounding boxes, anchor boxes. Sequence modelling: recurrent nets, architecture, vanishing and exploding gradient problem, Applications & use cases.

List of Course Seminar Topics:

1. Deep learning for Stock Market Clustering
2. Application of Deep Networks in health care
3. Credit card fraud detection
4. Classification of skin cancer with deep neural networks
5. ALEXNET
6. VCGNET
7. Accelerating Deep Network Training by Reducing Internal Covariate Shift
8. Deep learning applications for predicting pharmacological properties of drugs
9. GAN (Generalised Adversarial network)
10. Auto encoders
11. LSTM

List of Course Group Discussion Topics:

1. Recurrent or Recursive Networks for sequential Modelling?
2. Initializing network weights vs performance
3. Difficulty of training deep feedforward neural networks
4. Hyperparameter tuning: Is there a rule of thumb?
5. Problem of overfitting: How to handle?
6. Which cost function: Least squared error or binary cross entropy?
7. How to tackle with loss of corner information in CNN
8. Need of hundred classifiers to solve real world classification problem
9. Which optimization: Batch gradient descent or stochastic gradient descent
10. Activation functions: Comparison of trends
11. Remedy of problem of vanishing gradient and exploding gradient in RNN

List of Home Assignments:

Design:

1. Deep learning for library shelf books identification
2. Development of control system for fruit classification based on convolutional neural networks
3. Classifying movie review using deep learning
4. Sentiment analysis of the demonetization of economy 2016 India
5. Predicting Students Performance in Final Examination

Case Study:

1. Deep learning for security
2. Bag of tricks for efficient text classification
3. Convolutional Neural Networks for Visual Recognition
4. Deep Learning for Natural Language Processing
5. Scalable object detection using deep neural networks

Blog

1. Brain tumor segmentation with deep neural networks
2. Region-based convolutional networks for accurate object detection and segmentation
3. Human pose estimation via deep neural networks
4. Content Based Image Retrieval
5. Visual Perception with Deep Learning
6. Music genre classification system

Surveys:

1. Machine translation using deep learning - survey
2. Shaping future of radiology using deep learning
3. Training Recurrent Neural Networks
4. Text generation with LSTM
5. Deep learning applications in Biomedicine

Assessment Scheme:

Mid Semester Examination - 30 Marks

Home Assignment - 10 Marks

End Semester Examination - 30 Marks

Comprehensive Viva Voce - 30 Marks

Text Books:

1. Goodfellow, I., Bengio, Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. C., M., Pattern Recognition and Machine Learning, Springer, 2006.

Reference Books:

1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

MOOCS Links and additional reading material:

1. www.nptelvideos.in
2. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs11>
3. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs50>

Course Outcomes: Students will be able to

1. Demonstrate understanding of a logistic regression model, structured as a shallow Neural network.
2. Build and train a deep Neural Network.
3. Apply techniques to improve neural network performance.
4. Demonstrate understanding of functionality of all layers in a convolutional neural network.
5. Implement convolutional networks for image recognition/classification tasks.
6. Demonstrate Understanding of Recurrent nets and their applications.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	2	3	1	-	0	2	1	1	2	1	1
2	3	3	3	2	3	2	-	0	2	1	1	2	3	3
3	3	3	3	3	3	2	-	0	2	1	1	2	3	3
4	3	3	3	3	3	2	-	0	2	1	1	2	3	3
5	3	3	3	3	3	2	-	0	2	1	1	2	3	3
6	3	3	3	3	3	2	-	0	2	1	1	2	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels

CO1 - Level 3
CO 2 - Level 3
CO 3 - Level 5
CO 4 - Level 4
CO 5 - Level 5
CO 6 - Level 4

Future Courses Mapping:

Advanced course on Deep learning including Autoencoders and Boltzmann machines, Reinforcement Learning.

Job Mapping:

Deep learning engineer, Data Scientist and Algorithm Architect with industries in domains Healthcare, Industrials & Energy, Automobiles, Finance & Insurance, Human Resources, Agriculture, Cybersecurity, Ad & Marketing, Media and Entertainment, Government, Defense

ET 4292: MODERN DIGITAL COMMUNICATION TECHNIQUES

Teaching Scheme

Credits: 2..... Theory: 2 Hours/Week

Section 1: Topics/Contents

Introduction to digital communication systems, Source Coding, Characterization of Communication Signals & Systems, Signal space Representation, Representation of Memory less Modulation Methods, Nonlinear modulation methods

Section2: Topics/Contents

Optimal receivers of AWGN, Receiver for non-ideal channel, Probability of error of different modulation schemes, Fundamentals of estimation and detection theory used in digital communication, Carrier phase and symbol timing synchronization techniques, Channel estimation and equalization techniques, Power Adaptation methods for colored noise channel

Text Books:

1. Digital Communications by John G. Proakis
2. Digital Communications by Bernard Sklar
3. Digital Communications by Robert Gallager
4. Digital Communications by Simon Haykin
5. Modern Digital and Analog communications by B.P. Lathi.

ET4430: VLSI Design Flow: RTL To GDS

Credits:2.....

ABOUT THE COURSE:

This course covers the entire RTL to GDS VLSI design flow, going through various stages of logic synthesis, verification, physical design, and testing. Besides covering the fundamentals of various design tasks, this course will develop skills in modern chip design with the help of activities and demonstrations on freely available CAD tools. This course will enhance the employability of the students and will make them ready to undertake careers in the semiconductor industry.

PREREQUISITES: Basic Course on Digital Circuits (typically taught in the first/second year of UG Program)

INDUSTRY SUPPORT: The course develops skills to use design automation tools for chip designing. The course will be valued by companies working on semiconductors, such as Qualcomm, Intel, Texas Instruments, NXP, ST Microelectronics, Micron, IBM, Cadence, Synopsys, Siemens, ARM, AMD, NVidia, Apple, and Google.

Course layout

Week 1: Basic Concepts of Integrated Circuit: Structure, Fabrication, Types, Design Styles, Designing vs. Fabrication, Economics, Figures of Merit Overview of VLSI Design Flow: Design Flows and Abstraction; Pre-RTL Methodologies: Hardware-software Partitioning, SoC Design, Intellectual Property (IP) Assembly, Behavioral Synthesis

Week 2: Overview of VLSI Design Flow: RTL to GDS Implementation: Logic Synthesis, Physical Design; Verification and Testing; Post-GDS Processes

Week 3: Hardware Modeling: Introduction to Verilog Functional verification using simulation: testbench, coverage, mechanism of simulation in Verilog

Week 4: RTL Synthesis: Verilog Constructs to Hardware Logic Optimization: Definitions, Two-level logic optimization

Week 5: Logic Optimization: Multi-level logic optimization, FSM Optimization Formal Verification: Introduction, Formal Engines: BDD, SAT Solver

Week 6: Formal Verification: Model Checking, Combinational Equivalence Checking Technology Library: Delay models of Combinational and Sequential Cells

Week 7: Static Timing Analysis: Synchronous Behavior, Timing Requirements, Timing Graph, Mechanism, Delay Calculation, Graph-based Analysis, Path-based Analysis, Accounting for Variations

Week 8: Constraints: Clock, I/O, Timing Exceptions Technology Mapping Timing-driven Optimizations

Week 9: Power Analysis, Power-driven Optimizations Design for Test: Basics and Fault Models, Scan Design Methodology

Week 10: Design for Test: ATPG, BIST Basic Concepts for Physical Design: IC Fabrication, FEOL, BEOL, Interconnects and Parasitics, Signal Integrity, Antenna Effect, LEF files

Week 11: Chip Planning: Partitioning, Floorplanning, Power Planning Placement: Global Placement, Wirelength Estimates, Legalization, Detailed Placement, Timing-driven Placement, Scan Cell Reordering, Spare Cell Placement

Week 12: Clock Tree Synthesis: Terminologies, Clock Distribution Networks, Clock Network Architectures, Useful Skews Routing: Global and Detailed, Optimizations Physical Verification: Extraction, LVS, ERC, DRC, ECO and Sign-off

Books and references

1. Sneh Saurabh, "Introduction to VLSI Design Flow", Cambridge University Press, 2023 (expected) <https://www.cambridge.org/highereducation/books/introduction-to-vlsi-design-flow/93E6832E63FE6B795181D6D67B552333#overview>
2. M.J.S. Smith, "Application-specific integrated circuits", Addison-Wesley, 1997
3. L. Lavagno, I. L. Markov, G. Martin, and L. K. Scheffer (Editors), "Electronic Design Automation for IC Implementation, Circuit Design, and Process Technology", CRC Press, 2016
4. S. Palnitkar, "Verilog HDL: a guide to digital design and synthesis", Pearson Education India, 2003
5. J. Bhasker and R. Chadha, "Static timing analysis for nanometer designs: A practical approach", Springer Science Business Media, 2009
6. G. D. Micheli, "Synthesis and optimization of digital circuits", McGraw-Hill Higher Education, 1994
7. M. Bushnell and V. Agrawal, "Essentials of electronic testing for digital, memory and mixed-signal VLSI circuits", Springer Science & Business Media, 2004

Credits:2.....

This is a most fundamental Digital Circuit Design course for pursuing a major in VLSI. We do not deal with any Verilog coding during this course and instead discuss transistor level circuit design concepts in great detail. Over learning objectives of this course are:

- Characterize the key delay quantities of a standard cell
- Evaluate power dissipated in a circuit (dynamic and leakage)
- Design a circuit to perform a certain functionality with specified speed
- Identify the critical path of a combinational circuit
- Convert the combinational block to pipelined circuit
- Calculate the maximum (worst case) operating frequency of the designed circuit

Course layout

Week 1: The CMOS Inverter construction and Voltage Transfer Characteristics

Week 2: Resistance and Capacitance and transient response.

Week 3: Dynamic, Short Circuit and Leakage power – Stacking Effect

Week 4: Combinational Circuit Design and capacitance

Week 5: Parasitic Delay, Logical Effort and Electrical Effort

Week 6: Gate sizing and Buffering

Week 7: Asymmetric gate, Skewed gates, Ratio'ed logic

Week 8: Dynamic Gates and Domino logic and Static Timing Analysis

Week 9: Sequential circuits and feedback. Various D flip flop circuits – Static and Dynamic

Week 10: Setup and Hold Time measurement. Timing analysis of latch/ flop based systems

Week 11: Adders – Mirror adder, Carry Skip adder, Carry Select adder, Square Root adder

Week 12: Multipliers – Signed and Unsigned arithmetic, Carry Save Multiplier implementation

Credits:2.....

ABOUT THE COURSE:

This course covers the fundamentals of Digital Communications, and explores the building blocks of modern communication systems ranging from smartphones to optical fibers. Using the open source GNU Radio software, students will be able to design, simulate and analyze communication system models with ease.

REQUISITES: Signals and Systems, Probability and random processes

Course layout

Week 1: The GNU Radio Signal Model

Week 2: Complex baseband model and Analog modulation

Week 3: Transmission spectrum, bandwidth and pulse design

Week 4: Digital modulation, detection and noise

Week 5: Digital modulation, detection and noise (contd.)

Week 6: Symbol errors and bit errors

Week 7: Matched filtering, synchronization and channel estimation

Week 8: Matched filtering, synchronization and channel estimation (contd.)

Week 9: Digital Equalization

Week 10: Channels with inter-symbol interference and OFDM

Week 11: Introduction to binary error control coding

Week 12: Miscellaneous topics on GNU Radio and Digital Communication

Books and references

1. Fundamentals of Digital Communication, Upamanyu Madhow

2. Principles of Digital Communication, Robert Gallager

3. Digital Communications. Fifth Edition. John G. Proakis.

FF No. 654
ET4207: MAJOR PROJECT

Course Prerequisites: Basic Electronics, Physics, Engineering Mathematics, Statistics, Programming Languages

Course Objectives:

1. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student-centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a group to develop team skills and learn professionalism.
6. To develop entrepreneurship attitude

Credits: 9

Teaching Scheme Lab: 20 Hours/Week

Course Relevance:

Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. Students can be evaluated for higher order skills of Blooms taxonomy like ‘analyze, design and apply’. This course is capable of imparting hands-on experience and self learning to the students which will help them throughout their career. It emphasizes on learning by doing for a complete project life cycle, requirement analysis, realistic planning and transforming ideas into product. This is a step ahead in line with national policy of Atmanirbhar Bharat.

Major-Project Guidelines:

- The Major-project is a team activity having 3-4 students in a team. This is electronic product design work
- The Major-project may be a complete hardware or a combination of hardware and software work. The software part in Major-project should be less than 50% of the total work.
- After interactions with course instructor and based on comprehensive literature survey / requirement analysis, the student shall identify the title and define objectives of the Major-project.
- Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
- The student is expected to meet the timelines on design, development and testing of the proposed work.
- The student is instructed to have discussion with faculty instructor on standard practices used for electronic circuit / product design, converting the circuit design into a complete electronic product, PCD design using suitable simulation software, estimation of power budget analysis of the product, front panel / user interface design and mechanical aspects of the product.
- Completed Major-project and documentation in the form of Major-project report is to be submitted at the end of the semester. The project group will deliver the presentation of the Project Work which will be assessed by the panel.

Note: The student can identify a technological problem in the following sectors (The list is open ended):

1. Social relevance (Agriculture/ Water Management / Transportation / Waste Management / etc.)
2. Renewable Energy (Solar / Wind / Waves / etc.)
3. Green Technology (Carbon footprint / Pollution control / etc)
4. Assistive System for Weaker People (Blind / Deaf / Handicap assistive)
5. Security Enhancement (Cyber Security / Forensics) 6. Government Projects (Smart City / Smart Grid / Smart Gram / Swach Bharat / etc.)

Core Technology domains identified for E&TC Engg are as below. However, this list can be extended as per the need of project and multidisciplinary approach

1. VLSI Design
2. Embedded System
3. Signal Processing
4. Communication Engineering
5. Machine Learning

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

MOOCS Links and additional reading material:

www.nptelvideos.in
<https://worldwide.espacenet.com/>

Course Outcomes:

1. Review the literature to formulate problem statement to solve real world problems.
2. Apply knowledge of technology and modern tools to design solution considering sustainability and environmental issues.
3. Manage project ethically as team member/ lead.
4. Demonstrate effectively technical report/ research paper/ prototype/ patent.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	1	0	0	3	3	3	1	2	2	2
2	3	3	3	3	3	3	3	3	3	2	1	2	3	3
3	1	1	1	1	1	2	0	3	3	3	3	2	1	1
4	3	1	1	1	0	0	0	3	1	3	3	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels

CO1-Level 3

CO2- Level 4

CO3- Level 3

CO4- Level 4

ET4208: MAJOR PROJECT

Course Prerequisites: Basic Electronics, Physics, Engineering Mathematics, Statistics, Programming Languages

Course Objectives:

1. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student-centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a group to develop team skills and learn professionalism.
6. To develop entrepreneurship attitude

Credits: 10

Teaching Scheme Lab: 20 Hours/Week

Course Relevance:

Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. Students can be evaluated for higher order skills of Blooms taxonomy like ‘analyze, design and apply’. This course is capable of imparting hands-on experience and self learning to the students which will help them throughout their career. It emphasizes on learning by doing for a complete project life cycle, requirement analysis, realistic planning and transforming ideas into product. This is a step ahead in line with national policy of Atmanirbhar Bharat.

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- The Major-project is a team activity having 3-4 students in a team. This is electronic product design work
- The Major-project may be a complete hardware or a combination of hardware and software work. The software part in Major-project should be less than 50% of the total work.
- After interactions with course instructor and based on comprehensive literature survey / requirement analysis, the student shall identify the title and define objectives of the Major-project.
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- The student is expected to meet the timelines on design, development and testing of the proposed work.
- The student is instructed to have discussion with faculty instructor on standard practices used for electronic circuit / product design, converting the circuit design into a complete electronic product, PCD design using suitable simulation software, estimation of power budget analysis of the product, front panel / user interface design and mechanical aspects of the product.
- Completed Major-project and documentation in the form of Major-project report is to be submitted at the end of the semester. The project group will deliver the presentation of the Project Work which will be assessed by the panel.

Note: The student can identify a technological problem in the following sectors (The list is open ended):

6. Social relevance (Agriculture/ Water Management / Transportation / Waste Management / etc.)
7. Renewable Energy (Solar / Wind / Waves / etc.)
8. Green Technology (Carbon footprint / Pollution control / etc)
9. Assistive System for Weaker People (Blind / Deaf / Handicap assistive)
10. Security Enhancement (Cyber Security / Forensics)
6. Government Projects (Smart City / Smart Grid / Smart Gram / Swach Bharat / etc.)

Core Technology domains identified for E&TC Engg are as below. However, this list can be extended as per the need of project and multidisciplinary approach

1. VLSI Design
2. Embedded System
3. Signal Processing
4. Communication Engineering
5. Machine Learning

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

MOOCS Links and additional reading material:

www.nptelvideos.in
<https://worldwide.espacenet.com/>

Course Outcomes:

5. Review the literature to formulate problem statement to solve real world problems.
6. Apply knowledge of technology and modern tools to design solution considering sustainability and environmental issues.
7. Manage project ethically as team member/ lead.
8. Demonstrate effectively technical report/ research paper/ prototype/ patent.

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	1	0	0	3	3	3	1	2	2	2
2	3	3	3	3	3	3	3	3	3	2	1	2	3	3
3	1	1	1	1	1	2	0	3	3	3	3	2	1	1
4	3	1	1	1	0	0	0	3	1	3	3	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels

CO1-Level 3
CO2- Level 4
CO3- Level 3
CO4- Level 4

ET4431: DESIGN THINKING-7

Credits: 1

Teaching Scheme Tut: 1 Hour/Week

Course Objectives:

To provide ecosystem for students and faculty for paper publication and patent filing

Contents:

Structure of The paper
Journal List (Top 50 Journals)
Selection of the journal
Use of various online journal selection tools
Plagiarism checking
Improving contents of the paper
Patent drafting
Patent search
Filing of patent
Writing answers to reviewer questions
Modification in manuscript
Checking of publication draft

Suggest an assessment Scheme:

Publication of paper or patent

CO- PO Mapping

	1	2	3	4	5	6	7	8	9	10	11	12	PS O1	PS O2
CO 1	1	1	1	1	1	0	0	0	0	0	0	1	2	2
CO 2	1	1	1	1	1	0	0	0	0	0	0	1	0	1
CO 3	2	2	3	3	2	2	1	2	2	3	0	1	2	1
CO 4	3	3	3	3	3	2	1	2	2	3	1	1	0	0
CO 5	1	1	1	1	1	0	0	0	0	0	0	1	0	1
CO 6	2	2	2	2	2	2	1	3	2	3	3	1	0	1

CO 7	1	1	1	1	1	0	0	0	0	0	0	0	1	0	2
CO Attainment levels															
CO1	CO2	CO3	CO4	CO5	CO6	CO7	2	2	3	5	2	3	2		

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Syllabus of Final Year B.Tech.

Electronics & Telecommunication Engineering “Pattern – D25” Module - VIII

ET4251: INDUSTRY INTERNSHIP

ET4222: RESEARCH INTERNSHIP

ET4250: PROJECT INTERNSHIP

ET4252: INTERNATIONAL INTERNSHIP

Credits: 1

Teaching Scheme Lab: 32 Hours/Week

Industry/ Research/ Global Internship is an educational innovation seeking to link industry experience with university instruction. Internship enables students to acquire learning by applying the knowledge and skills they possess in open-ended real-life situations of a rapidly changing needs and challenges in a professional workplace. Internship provides the required platform for experiential and cooperative learning and education, by providing students with an opportunity to work on industry assignments, under the guidance of professional experts and under the supervision of faculty. Students are offered 18 weeks industry internship to enhance their skillset and get exposure of industry front. Internship facilitates and promotes partnership and intellectual exchange between academia and industry.

Course Outcomes:

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyze, formulate and develop projects with a comprehensive and systematic approach.
3. Cooperate with diverse teams and effectively communicate with all the stake holders.
4. Produce solutions within the technological guidelines and standards.
5. Develop effective communication skills for presentation of project related activities.

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

CO PO Map:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1	1	1	2	2	3	3	3	2	3	3	3
2	1	1	1	1	1	2	2	3	3	3	2	3	3	3
3	1	1	1	1	1	2	2	3	3	3	2	3	3	3
4	1	1	1	1	1	2	2	3	3	3	2	3	3	3
5	1	1	1	1	1	2	2	3	3	3	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels:

CO1:- Level 1

CO2:- Level 1

CO3:- Level 1

CO4:- Level 1

CO5:- Level 1

CO6:- Level 1

ET4401: INDUSTRY INTERNSHIP

ET4403: RESEARCH INTERNSHIP

ET4404: PROJECT INTERNSHIP

ET4402: INTERNATIONAL INTERNSHIP

Credits: 16

Teaching Scheme Lab: 32 Hours/Week

Industry/ Research/ Global Internship is an educational innovation seeking to link industry experience with university instruction. Internship enables students to acquire learning by applying the knowledge and skills they possess in open-ended real-life situations of a rapidly changing needs and challenges in a professional workplace. Internship provides the required platform for experiential and cooperative learning and education, by providing students with an opportunity to work on industry assignments, under the guidance of professional experts and under the supervision of faculty. Students are offered 18 weeks industry internship to enhance their skillset and get exposure of industry front. Internship facilitates and promotes partnership and intellectual exchange between academia and industry.

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2. Identify, analyze, formulate and develop projects with a comprehensive and systematic approach.
3. Cooperate with diverse teams and effectively communicate with all the stake holders.
4. Produce solutions within the technological guidelines and standards.
5. Develop effective communication skills for presentation of project related activities.

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

CO PO Map:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1	1	1	2	2	3	3	3	2	3	3	3
2	1	1	1	1	1	2	2	3	3	3	2	3	3	3
3	1	1	1	1	1	2	2	3	3	3	2	3	3	3
4	1	1	1	1	1	2	2	3	3	3	2	3	3	3
5	1	1	1	1	1	2	2	3	3	3	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO attainment levels:

CO1:- Level 1

CO2:- Level 1

CO3:- Level 1

CO4:- Level 1

CO5:- Level 1

CO6:- Level 1

