UNIVERSITY OF KERALA

Syllabus For B.Tech INFORMATION TECHNOLOGY

2020 SCHEME

SEMESTER VIII

SEMESTER VIII

SLOT	Course No.	COURSES	L-T-P	Hours	Credit
A	ITT402	CRYPTOGRAPHY AND NETWORK SECURITY	2-1-0	3	3
B	ITTXXX	PROGRAM ELECTIVE III	2-1-0	3	3
C	ITTXXX	PROGRAM ELECTIVE IV	2-1-0	3	3
D	ITT404	PROGRAM ELECTIVE V	2-1-0	3	3
E	ITD416	COMPREHENSIVE COURSE VIVA	1-0-0	1	1
U	ITD416	PROJECT PHASE II	0-0-12	12	4
R\M/H	VAC	Remedial/Minor/Honors course	3-1-0	4*	4
	TOTAL			**29**	**17/21**

PROGRAM ELECTIVE III

SLOT	Course No.	COURSES	L-T-P	Hours	Credit
B	ITT413	MOBILE COMPUTING	2-1-0	3	3
	ITT423	ARTIFICIAL INTELLIGENCE	2-1-0		
	ITT433	OBJECT ORIENTED MODELING AND DESIGN	2-1-0		
	ITT443	ADVANCED DATABASE MANAGEMENT SYSTEMS	2-1-0		
	ITT453	MACHINE LEARNING	2-1-0		
	ITT463	OPTIMIZATION AND METAHEURISTICS	2-1-0		
	ITT473	PROBABILISTIC AND STOCHASTIC MODELLING	2-1-0		

PROGRAM ELECTIVE IV

SLOT	Course No.	COURSES	L-T-P	Hours	Credit
C	ITT416	SOCIAL NETWORKS ANALYSIS	2-1-0	3	3
	ITT426	INTERNET OF THINGS	2-1-0		
	ITT436	HIGH SPEED NETWORKS	2-1-0		
	ITT446	ADHOC AND WIRELESS SENSOR NETWORKS	2-1-0		
	ITT456	HUMAN COMPUTER INTERFACING	2-1-0		
	ITT466	PIPELINING AND PARALLEL PROCESSING	2-1-0		
	ITT476	NETWORK SCIENCE	2-1-0		

PROGRAM ELECTIVE V

SLOT	Course No.	COURSES	L-T-P	Hours	Credit
D	ITT418	INFORMATION STORAGE MANAGEMENT	2-1-0	3	3
	ITT428	SOFTWARE QUALITY ASSURANCE	2-1-0	3	3
	ITT438	SOFTWARE ARCHITECTURE	2-1-0	3	3
	ITT448	NETWORK ON CHIPS	2-1-0	3	3
	ITT458	NATURAL LANGUAGE PROCESSING	2-1-0	3	3
	ITT468	BIOINFORMATICS	2-1-0	3	3
	ITT478	DEEP LEARNING	2-1-0	3	3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT402	CRYPTOGRAPHY AND NETWORK SECURITY	PCC	2	1	0	3

Preamble: Cryptography is essentially important for secure communication in digital form and to provide security services in today's internet environment. The syllabus is prepared with a view to provide the Engineering Graduates a better foundation in cryptography and network security.

Prerequisite: MAT203Discrete Mathematical Structures, ITT305 Data Communication and Networking

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Apply the concepts of number theory in designing crypto systems	Level 3: Apply
CO 2	Explain various network security aspects, cryptanalytic attacks and classical cryptosystems	Level 2: Understand
CO 3	Describe various symmetric key cryptosystems, hash and message authentication functions.	Level 2: Understand
CO 4	Apply the principles of asymmetric key cryptosystems and digital signature.	Level 3: Apply
CO 5	Discuss various protocols to ensure Email Security and Network Security.	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	2	-	-	-	-	-	-	-	-	1
CO 2	1	1	2	-	-	-	-	-	-	-	-	-
CO 3	1	-	-	-	-	-	-	-	-	-	-	1
CO 4	3	-	-	-	1	-	-	-	-	-	-	1
CO 5	1	2	1	-	2	-	-	-	-	-	-	1

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
BL 1: Remember	10	10	20
BL 2: Understand	30	30	60
BL 3: Apply	10	10	20
BL 4: Analyse			
BL 5: Evaluate			
BL 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Using Euclid's algorithm, obtain the greatest common divisor of the(42, 105, 91).
2. Find 33^{100} mod 40 (use Euler's theorem).
3. Compute the value of x for the set of congruence given using Chinese Remainder Theorem. $x \equiv 4 \bmod 5$, and $x \equiv 10 \bmod 11$.
4. Define Fermat's theorem and list out its applications.

Course Outcome 2 (CO 2):

1. Describe the three security goals of Information Security.
2. Explain with examples some of the attacks threatening confidentiality and integrity.
3. Encrypt the message "beware of strangers" using Vigenere cipher with key "dollars". Ignore the space between words. Decrypt the message to get the plain text.
4. Compare stream cipher and block cipher with example.

Course Outcome 3 (CO 3):

1. Summarize the key generation process in DES.
2. With suitable examples, explain the significance of hash function for message authentication.
3. List and briefly describe the design objectives of HMAC.
4. Explain the single round operation of SHA-512.

Course Outcome 4 (CO 4):

1. Perform encryption and decryption using RSA algorithm for the following. P=7; q=11; e=13; M=8.
2. Identify the possible threats for the RSA algorithm and list their countermeasures.
3. Demonstrate man in the middle attack on Diffie Hellman key exchange algorithm.
4. Explain the digital signature algorithm with suitable diagrams.

Course Outcome 5 (CO 5):

1. Describe the various ways to distribute public keys in cryptography.
2. Sketch and explain the transmission and reception of PGP Messages.
3. Give the format of Authentication Header in IPSec.
4. Explain the features of any two types of firewalls.

Model Question Paper

Course Code: ITT402

Course Name: CRYPTOGRAPHY AND NETWORK SECURITY

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Identify the number of primes less than 1,000,000.
2. Compute 33^{100} (mod 40) (use Euler's theorem).
3. With an example, explain the encryption and decryption process of Caesar Cipher.
4. Compare stream cipher and block cipher with example.
5. "The decryption mode of DES is inverse of its decryption mode". Justify the above statement with your comments.
6. Compare the round keys in DES and AES. In which cipher is the size of the round key the same as the size of the block?
7. Consider a Diffie Hellman scheme with a common prime q = 11 and primitive root $\alpha = 2$. If user A has public key YA = 9 and user B has public key YB = 3, estimate A's private key and the shared secret key K between A and B.
8. Explain the steps for the verifying process in RSA digital signature scheme.
9. Discuss about the various types of firewalls.
10. Distinguish between Direct DDoS and Reflector DDoS.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11 a. Compute gcd(85,289).
Using Euclid's extended algorithm, obtain x and y such that
85x+ 289y = gcd(85, 289). 7

b. Find the particular and general solutions to the equation 21x+14y=35. 7

OR

12 a. Solve the system of simultaneous congruences using Chinese remainder theorem

$x \equiv 6 \pmod{11}$
$x \equiv 13 \pmod{16}$
$x \equiv 9 \pmod{21}$
$x \equiv 19 \pmod{25}$ 8

b. Using Fermat theorem evaluate the following:

$6^{10} \bmod 11$
$3^{12} \bmod 11$
$5^{984} \bmod 7$ 6

13 a. List and explain the security mechanisms defined by X.800. 8

b. Illustrate the encryption of given message using Playfair cipher with the keyword "GUIDANCE".
Message: MEET ME AT THE TOGA PARTY 6

OR

14 a. Describethe various cryptanalytic attacks on cryptosystems. 10

b. Consider the encryption key in a transposition cipher is (3,2,6,1,5,4). Determine the corresponding decryption key. 4

15 a. Demonstrate the single round operation in the DES algorithm. 10

b. List and briefly describe the design objectives of HMAC. 4

OR

16 a. Outline the following round operations in AES cipher: 10

i. Substitute Bytes Transformation
ii. ShiftRows Transformation
iii. MixColumns Transformation
iv. AddRound Key Transformation

b. Distinguish between HMAC and CMAC. 4

17 a. Illustrate in detail about the message authentication code and its 7 requirements.

b. Alice and Bob agreed to use RSA algorithm for the secret communication. 7
Alice securely chooses two primes, p=5 and q=11 and a secret key d=7. Find the corresponding public key. Bob uses this public key and sends a cipher text 18 to Alice. Obtain the plain text.

OR

18 a. Consider an ElGamal scheme with a common prime p =71 and a primitive

root x =7.

1. If Bob has public key y = 3 and Alice chose the random integer k = 2, Find the ciphertext of M = 30.

2. If Alice now chooses a different value of k, so that the encoding of M = 30 is C = (59, C2), determine the integer C2. 8

b. Describe signing and verification in Digital Signature Algorithm. 6

19 a. Explain the sequence of steps involved in the message generation and reception in Pretty Good Privacy (PGP) with block diagrams. 10

b. Sketch and explain IPSec ESP Format. 4

OR

20 a Illustrate the working of Secure Electronic Transaction (SET) in detail. 7

b. Summarize any two techniques proposed for the distribution of public keys. 7

Syllabus

Module 1: Basics of Algebra and Number Theory (7 Hours)
Integer Arithmetic -Divisibility - Greatest Common Divisor - Extended Euclidean Algorithm- Linear Diophantine equation, Modular Arithmetic - Modulo Operator - Congruence - Addition and multiplicative inverse, Algebraic structures - Field - Finite fields of the form GF(p) and GF(2^n) - Polynomial arithmetic, Prime Numbers - Fermat's and Euler's Theorem - Prime Factorization by Trial Division Method - Chinese Remainder Theorem.
Module 2: Introduction to Security (8 Hours)
Security Goals, Security Services-Confidentiality -Integrity - Authentication- Non-repudiation- Access control, Security Mechanisms–Encipherment- Data Integrity- Signature-Authentication Exchange-Traffic Padding- Routing Control- Notarization- Access Control, Introduction to Cryptography -Classification of Cryptosystems, Cryptanalytic attacks, CipherProperties - Confusion- Diffusion. Classical Cryptosystems - Substitution Techniques - Monoalphabetic Cipher - Caesar Cipher- AffineCipher, Polyalphabetic Ciphers - Autokey Cipher- Playfair Cipher-Hill Cipher-VigenereCipher- One Time Pad Cipher, Stream and Block Ciphers, Modern Secret Key Ciphers - Substitution Box-Permutation Box-Product Ciphers.
Module 3: Private Key Cryptography and Hash Function (7 Hours)
Data Encryption Standard - DES - Structure of DES - DES Attacks - 2-DES - 3-DES, Advanced Encryption Standard - AES - Structure-Analysis, Cryptographic Hash Functions - Properties - Secure Hash Algorithm - SHA-512 Logic - SHA-512 Round Function, Message Authentication Code -Hash-based Message Authentication Code -HMAC - Cipher-based Message Authentication Code - CMAC.
Module 4: Public Key Cryptography and Digital Signature (7 Hours)
Public Key Cryptosystems -PKC - Types of PKC - Trapdoor - One-way functions, RSA Cryptosystem -Key Generation – Encryption- Decryption,ElGamal Cryptosystem - Key Generation – Encryption-Decryption, Diffie-Hellman Key Exchange Protocol- Man in the Middle attack on Diffie-Hellman Protocol. Digital Signature- Signing - Verification, Digital signature forgery-Existential forgery-Selective forgery- Universal forgery, RSA Digital Signature Scheme -ElGamal Signature Scheme.
Module 5: Key Distribution and Network Security (6Hours)

Symmetric Key Distribution using Symmetric and Asymmetric Encryption - Distribution of public keys -Public announcement-

Public available directory-Public-key authority- Public-key Certificates.
Electronic Mail Security -Pretty Good Privacy- PGP message format - Transmission and Reception of PGP Messages, IP Security Overview - IP Authentication Header - Encapsulating Security Payload - Distributed Denial of Service attacks, Secure Electronic Transaction – Payment Processing - Dual Signature, Firewalls - Firewall Design Principles.

Text Books

1. Stallings W., Cryptography and Network security: Principles and Practice, 7/e, Pearson Education Asia, 2017.
2. Stallings W., Cryptography and Network security: Principles and Practice, 4/e, Pearson Education Asia, 2006.
3. Behrouz A Forouzan & Debdeep Mukhopadhyay, "Cryptography and Network. Security", Second Edition, Tata McGraw Hill Education Pvt Ltd Publication, 2010.

Reference Books

1. AtulKahate, "Cryptography and Network Security, 4e", Tata McGraw Hill,2019.
2. Bernard Menezes, Network Security and Cryptography-Cengage Learning India, 2011
3. Thomas Mowbray, "Cybersecurity: Managing Systems Conducting Testing, and Investigating Intrusions", John Wiley, 2014
4. Charles P. Pleeger, Shari Lawrence Pfleeger, "Security in Computing", Pearson Education Asia, 5thEdition, 2018.
5. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: PRIVATE Communication in a PUBLIC World, Pearson Education India, 2016.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Basics of Algebra and Number Theory**	**7Hours**
1.1	Integer Arithmetic - Divisibility - Greatest Common Divisor	1
1.2	Extended Euclidean Algorithm	1
1.3	Linear Diophantine equation	1
1.4	Modular Arithmetic - Modulo Operator - Congruence - Addition and multiplicative inverse	1
1.5	Algebraic structures - Field - Finite fields of the form GF(p) and GF(2^n) - Polynomial arithmetic	1
1.6	Prime Numbers - Fermat's and Euler's Theorem- Prime Factorization by Trial Division Method	1
1.7	Chinese Remainder Theorem	1

2	**Introduction to Security**	**8 Hours**
2.1	Security Goals, Security Services – Confidentiality-Integrity Authentication- Non-repudiation- Access control, Security Mechanisms - Encipherment- Data Integrity - Signature-Authentication Exchange-Traffic Padding- Routing Control - Notarization-Access Control	1
2.2	Introduction to Cryptography -Classification of Cryptosystems, Cryptanalytic attacks, Cipher Properties-Confusion- Diffusion.	1
2.3	Classical Cryptosystems - Substitution Techniques - Monoalphabetic Cipher	1
2.4	Caesar Cipher- Affine Cipher	1
2.5	Polyalphabetic Ciphers - Autokey Cipher- Playfair Cipher	1
2.6	Hill Cipher- Vigenere Cipher- One Time Pad Cipher	2
2.7	Stream and Block Ciphers, Modern Secret Key Ciphers-Substitution Box-Permutation Box-Product Ciphers	1
3	**Private Key Cryptography and Hash Function**	**7 Hours**
3.1	Data Encryption Standard -DES- Structure of DES- DES Attacks - 2-DES - 3-DES	2
3.2	Advanced Encryption Standard -AES -Structure-Analysis	2
3.3	Cryptographic Hash Functions – Properties	1
3.4	Secure Hash Algorithm - SHA-512 Logic - SHA-512 Round Function	1
3.5	Message Authentication Code - Hash-based Message Authentication Code -HMAC - Cipher-based Message Authentication Code - CMAC	1
4	**Public Key Cryptography and Digital Signature**	**7 Hours**
4.1	Public Key Cryptosystems -PKC - Types of PKC - Trapdoor - One-way functions- RSA Cryptosystem -Key Generation-Encryption-Decryption	2
4.2	ElGamal Cryptosystem - Key Generation – Encryption-Decryption	2
4.3	Diffie-Hellman Key Exchange Protocol- Man in the Middle attack on Diffie-Hellman Protocol.	1
4.4	Digital Signature- Signing - Verification, Digital signature forgery-Existential forgery- Selective forgery- Universal forgery	1

4.5	RSA Digital Signature Scheme - ElGamal Signature Scheme.	1
5	**Key Distribution and Network Security 6 Hours**	
5.1	Symmetric Key Distribution using Symmetric and Asymmetric Encryption	1
5.2	Distribution of public keys -Public announcement- Public available directory-Publickey authority- Publickey Certificates	1
5.3	Electronic Mail Security - Pretty Good Privacy- PGP message format - Transmission and Reception of PGP Messages	1
5.4	IP Security Overview - IP Authentication Header - Encapsulating Security Payload, Distributed Denial of Service attacks	1
5.5	Secure Electronic Transaction- Payment Processing -Dual Signature	1
5.6	Firewalls - Firewall Design Principles	1

SEMESTER VIII

PROGRAM ELECTIVE III

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT414	COMPUTER VISION	PEC	2	1	0	3

Preamble: The syllabus is prepared with a view to equip the Engineering Graduates to learn basic concepts in data communication and computer networking, and to fine-tune performance parameters used in data transmission

Prerequisite: Nil

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Explain the foundations of Computer Vision	Level 2: Understand
CO 2	Evaluate the different feature extraction techniques and develop an object recognition system using handcrafted features and classifiers.	Level 3: Apply
CO 3	Discuss the concepts of neural networks, logistic regression and develop an image classification system using minimal neural network	Level 3: Apply
CO 4	Explain the fundamentals of Convolutional Neural Network (CNN) and develop an image classification system using CNN	Level 3: Apply
CO 5	Develop an image classification/object detection system using pre-trained models or auto-encoders	Level 3: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	-	-	-	-	-	-	-	-	-	2
CO 2	3	2	2	-	-	-	-	-	-	-	-	1
CO 3	3	3	2	-	-	-	-	-	-	-	-	1
CO 4	3	3	2	-	-	-	-	-	-	-	-	1
CO 5	3	2	2	1	-	-	-	-	-	-	-	1

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	10		10
Level 2: Understand	25	25	55
Level 3: Apply	15	25	35
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Compare and contrast the Image Processing vs Computer Vision.
2. What are the different types of color spaces?
3. Mention the various geometric transforms.
4. Give a comparative analysis of different kinds of image filtering.
5. Mention the various color transforms.
6. Compare and contrast the functionalities of basic image operations.

Course Outcome 2 (CO 2):

1. Differentiate between SIFT and SURF..

2. Explain Image pyramids and Fourier transform
3. Differentiate between FLANN and RANSAC.
4. Explain the process of Back propagation
5. Develop a solution for Coin Detection problem.

Course Outcome 3 (CO 3):

1. Explain the steps in image classification
2. Develop an Image Classification using minimal neural network as second part of assignment1.
3. Explain how logistic regression is performed in the neural network
4. Explain the role of softmax in the neural network
5. Define Stochastic Gradient Descent

Course Outcome 4 (CO 4):

1. Explain the Building Blocks of CNN
2. Explain the role of Batch Normalization and Dropout in CNN
3. Define Hyper parameter Tuning
4. Develop an Image Classification using CNN as the first part of assignment2.

Course Outcome 5 (CO 5):

1. Develop an Object detection using SSD/YOLO as the second part of assignment2.
2. Explain Generative Adversarial Network (GAN)
3. Explain the steps in Human Pose Estimation
4. Explain the steps in action recognition in video

Model Question Paper

Course Code: ITT414
Course Name: COMPUTER VISION

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Explain the different components of a vision system.
2. Compare and contrast the functionalities of basic image operations.
3. Explain Thresholding, Erosion and Dilation.
4. Explain Advanced Histogram Equalization(CLAHE)
5. Explain LBP features.
6. Describe the different steps in image classification with a neat diagram.
7. Describe the steps in Auto encoders.
8. Explain the role of Batch Normalization and Dropout in CNN.
9. What is meant by a pose?

10. Explain the different steps involved in object detection.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11 Compare and contrast the Image Processing VS Computer Vision and mention different applications of Computer vision. 14

OR

12 a Differentiate between Contrast Enhancement and Brightness Enhancement. 9

b Describe the basic image operations 5

.

13 Perform histogram equalization on the following 8 X8 image. The grey level distribution of the image is given below 14

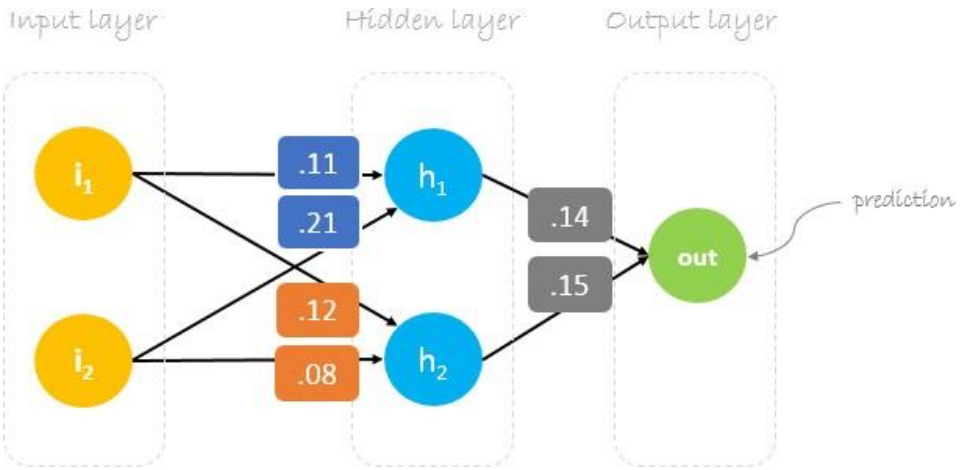
Gray level(rk)	0	1	2	3	4	5	6	7
No. of pixel(pk)	8	10	10	2	12	16	4	2

OR

14 a Differentiate between First Order Derivative Filters and Second Order Derivative Filters 10

b Why smoothing is important before Gradient? 4

15 Explain back propagation for the following network for the inputs=[2, 3] and output=[1] 14



OR

16 a Differentiate between Affine Transform and Hough Transforms 10

b Explain in detail about Image pyramids and Fourier transform 4

17	a	List and explain the issues in training a CNN	10
	b	Explain the different layers of CNN	4
		OR	
18	a	Explain the best practices in transfer learning and describe the advantages and disadvantages of transfer learning	10
	b	Explain the relu activation function in CNN	4
19	a	Explain object detection in detail	10
	b	Differentiate between YOLO and SSD	4
		OR	
20	a	Explain in detail about action recognition and GAN	10
	b	Explain Video classification	4

Syllabus

Module 1: Overview of Computer Vision (6 Hours)
Introduction to Computer Vision -Image Processing VS Computer Vision Problems in Computer Vision. **Introduction to images**- How images are formed, Digital Image, Image as a Matrix, Manipulating Pixels, Color Image, Image Channels, Splitting and Merging Channels, Manipulating Color pixels, Images with Alpha Channel **Basic image operations**- Cropping an image Section, Resizing an image, Creating an image mask, Mathematical operations on images- Data Type Conversion, Contrast Enhancement, Brightness Enhancement.
Module 2: Image Processing and Enhancements(7 Hours)
Thresholding, Overview on Erosion and Dilation, Overview on Opening and Closing, Connected Component Analysis, Contour Analysis, Blob Detection, Color Spaces- RGB Color Space, HSV Color Space, Other Color Space, Color Transforms-Histogram Equalization, Advanced Histogram Equalization(CLAHE), Image Filtering- Box Blur, Gaussian Blur, Median Blur, Bilateral Filtering, Introduction to Image Gradients First Order Derivative Filters, Why smoothing is important before Gradient, Second Order Derivative Filters, Convolution
Module 3: Image transforms and Features (8 Hours)
Geometric Transforms- Affine Transform, Homography, Hough Transforms, Image pyramids and Fourier transform, Image Inpainting, Image Features-ORB, SIFT, SURF, HOG, WLD, LBP, Feature Matching-Brute-Force Matcher, FLANN,RANSAC, Neural Networks – Stochastic Gradient Descent – Backpropagation – Logistic Regression – Softmax. Implementation: Image Classification using minimal neural network

Module 4: Deep Learning(7 Hours)
Convolutional Neural Networks: Building Blocks –Hyperparameter Tuning –Learning-Visualizing CNNs – Batch Normalization and Dropout – Deconvnets. Implementation: Simple Image classification using CNN. Transfer Learning – Pre-trained Models – Autoencoders. Implementation: Image Classification using Pre-trained models/Autoencoders
Module 5: Object detection (7 Hours)
Generative Adversarial Network (GAN), Object Detection- Single Shot Multibox Detector(SSD), You Only Look Once Detector(YOLO) Application: Video Classification-Streaming CNN for action recognition-3D convolution for temporal learning– Segmenting and captioning videos. Human Pose Estimation

Text Books

1. Rafael C. Gonzalez, Richard E.Woods, Digital Image Processing, Pearson Education,4/e,2018
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 1st Ed., 2010.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning, The MIT Press, 2017

References

1. Linda G. Shapiro, George C. Stockman, "Computer Vision", Prentice Hall, 1st Ed., 2001.
2. Charu C Aggarwal. Neural Networks and Deep Learning, Springer, 2018
3. Eugene Charniak. Introduction to Deep Learning, The MIT Press, 2019
4. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", 2nd Ed., 2011.
5. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 1st Ed., 2012.
6. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck, "Machine Vision", McGraw-Hill, 1st Ed., 1995

Course Contents and Lecture plan

Sl.No.	Topic	Number of Lectures
1	**Introduction to Computer Vision**	**(5 Hours)**
1.1	Image Processing vs Computer Vision, Problems in Computer Vision.	1
1.2	**Introduction to images**- How images are formed, Digital Image, Image as a Matrix, Manipulating Pixels.	1
1.3	Color Image, Image Channels, Splitting and Merging Channels, Manipulating Color pixels, Images with Alpha Channel.	1
1.4	**Basic image operations**- Cropping an image Section, Resizing an image, Creating an image mask.	1

1.5	Mathematical operations on images- Data Type Conversion, Contrast Enhancement, Brightness Enhancement.	1
2	**Image Processing and Enhancements**	**(7 Hours)**
2.1	Thresholding, Overview on Erosion and Dilation, Overview on Opening and Closing, Connected Component Analysis, Contour Analysis, Blob Detection.	1
2.2	Color Spaces- RGB Color Space, HSV Color Space, Other Color Space.	1
2.3	Color Transforms-Histogram Equalization, Advanced Histogram Equalization (CLAHE).	1
2.4	Image Filtering- Box Blur, Gaussian Blur.	1
2.5	Median Blur, Bilateral Filtering.	1
2.6	Introduction to Image Gradients, First Order Derivative Filters, Why smoothing is important before Gradient.	1
2.7	Second Order Derivative Filters, Convolution	1
3	**Image transforms and Features**	**(8 Hours)**
3.1	Geometric Transforms- Affine Transform.	1
3.2	Homography, Hough Transforms.	1
3.3	Image pyramids and Fourier transform.	1
3.4	Image Inpainting, Image Features-ORB, SIFT, SURF, HOG, WLD, LBP.	1
3.5	Feature Matching-Brute-Force Matcher.	1
3.6	Neural Networks – Stochastic Gradient Descent.	1
3.7	Back-propagation.	1
3.8	Logistic Regression – Softmax. Implementation:Image Classification using minimal neural network.	1
4	**Deep Learning**	**(8 Hours)**
4.1	Convolutional Neural Networks	1
4.2	Hyperparameter Tuning – Learning.	1
4.3	Visualizing CNNs – Batch Normalization and Dropout	1
4.4	Deconvnets.	1
4.5	Implementation: Simple Image classification using CNN	1
4.6	Transfer Learning	1
4.7	Pre-trained Models	1
4.8	Implementation: Image Classification using Pre-trained models/Autoencoders	1
5	**Object detection**	**(7 Hours)**
5.1	Generative Adversarial Network (GAN)	1
5.2	Object Detection- Single Shot Multibox Detector(SSD)	1

5.3	You Only Look Once Detector(YOLO) Application	1
5.4	Video Classification- Streaming CNN for action recognition	1
5.5	3D convolution for temporal learning.	1
5.6	Segmenting and captioning videos	1
5.7	Human Pose Estimation	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT424	CYBER AND NETWORK FORENSICS	PEC	2	1	0	3

Preamble: The syllabus is prepared with a view to equip the Engineering Graduates to learn the basics of Windows, Linux, Network and Cyber forensics. At the end of the course students will understand various elements associated in digital forensics.

Prerequisite: Knowledge in Operating Systems and Computer Networks.

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Explain the concepts in cyber forensics and forensics investigation process	Level 2: Understand
CO 2	Explain the elements in the Windows forensics, including malwares and its effects	Level 2: Understand
CO 3	Explain the elements in the Linux operating system, and Linux distribution assisting in cyber forensic	Level 2: Understand
CO 4	Illustrate the various challenge that cyber forensic experts encounter with the modern cybercriminals	Level 3: Apply
CO 5	Show networking-related digital evidence by monitoring, recording, analysing, and interpreting of network traffic.	Level 3: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1	-	-	1	-	1	-	-	-	2
CO 2	1	2	1	-	-	-	-	1	-	-	-	2
CO 3	1	2	1	-	-	-	-	1	-	-	-	2
CO 4	1	2	2	2	-	1	-	1	-	-	-	2
CO 5	2	2	2	2	-	1	-	1	-	-	-	2

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	10	10	20
Level 2: Understand	40	30	60
Level 3: Apply		10	20
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Show the forensics investigation process
2. Discuss the various types of cybercrimes
3. Write notes on recent cyber security trends
4. Explain cyber forensic tools.

Course Outcome 2 (CO 2):

1. Compare the volatile evidence artifacts and non-volatile artifacts in Windows.
2. Outline Windows file system.

3. Demonstrate Autopsy Tool used in Windows Forensics
4. Illustrate Malware Forensics.

Course Outcome 3 (CO 3):

1. Outline Linux File System concepts.
2. Explain the Linux distributions used in forensic analysis.
3. Interpret Windows and Linux from a forensics perspective.
4. Show Linux partitions and memory with the forensic tools.

Course Outcome 4 (CO 4):

1. Identify anti-forensic practices.
2. Examine Spoofing and Data Modification
3. Make use of anti-forensics detection techniques.
4. Examine the affected files in an attack with various tools.

Course Outcome 5 (CO 5):

1. Make use of network forensic artifacts
2. Examine the network traffic with forensic tools
3. Identify various attacks in web and computer networking
4. Examine email forensic investigation

Model Question Paper

Course Code: ITT424

Course Name: CYBER AND NETWORK FORENSICS

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks. (10 * 3 = 30 Marks)

1. Explain cyber forensics.
2. Write notes on digital evidence.
3. Explain how a malware affects Windows ecosystem
4. Write notes on any tool used in Windows to detect the tampering of data
5. List and explain any 3 Linux distributions available in the market now.
6. Differences between Windows and Linux from a forensics perspective.
7. Write notes on any tool used for anti-forensics detection.
8. Explain the Steganography process.
9. Write short note on Phishing.
10. Explain the need of Wireshark in Network Forensics.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11	a.	Explain the various types of cybercrimes	7
	b.	Explain the challenges in Cyber Forensics	7
		OR	
12	a.	List and explain the four characteristics of digital evidence	5
	b.	Explain the forensics investigation process	9
13	a.	Explain the Non-volatile Artifacts in Windows affecting a forensic investigation.	14
		OR	
14	a.	Discuss Windows File System in detail	9
	b.	Explain the challenges associated with Malware analysis	5
15	a.	Describe Forensic Process for Linux Systems in detail	14
		OR	
16	b.	Describe Linux File System in detail	14
17	a.	Explain Degaussing	5
	b.	Explain the different Anti-forensic Practices in detail.	9
		OR	
18	a.	Describe the tools and techniques used for manipulation of evidence to mislead the investigation	14
19	a.	List any five Top 10 Risks listed in Open Web Application Security Project	5
	b.	Examine Intrusion Forensics in detail	9
		OR	
20	a.	Explain Two-Factor Authentication	4
	b.	Examine network artifacts that provide evidence or insights into network communication.	10

Syllabus

Module 1: Introduction to Cyber Forensics (7 Hours)
Introduction to Cyber Forensics, Cyber Forensics, Forensics Investigation Process - Forensic Protocol for Evidence Acquisition - Digital Forensics Standards and Guidelines - Digital Evidence - Cybercrime, Types of Cybercrimes - Recent Data Breaches - Recent Cybersecurity Trends - Case Study: Sim Swapping Fraud, ATM Card Cloning, Hacking email for money, Google Nest Guard. Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert, Cyber Forensic Tools
Module 2: Windows Forensics (7 Hours)
Digital Evidence in Windows: Volatile Evidence Artifacts, Non-volatile Artifacts, Master File Table (MFT), MBR, Windows Registry, Event Logs, Configuration Files, Temporary Files, SWAP Files, Unallocated Space – File System: FAT32, NTFS -Rootkits and Rootkit Detection: Rootkits,Rootkit Detection - Case Study: Autopsy Tool. Malware Forensics: Types of Malware, Malware Analysis: Static Analysis, Dynamic Analysis, Tools for Analysis, Case Study: Windows Malware Analysis of Data Stealing Malware
Module 3: Linux Forensics (7 Hours)
Linux Distributions, File System, Forensic Artifacts, Special Artifacts, Linux Distributions Used for Forensic Analysis: Kali, DEFT - Live Response: Prepare the Target Media, Format the Drive, Gather Volatile Information, Acquiring the Image - Differences Between Windows and Linux from a Forensics Perspective, Case Study: Listing Partitions, Memory Acquisition of Linux System, SysScout Tool, Raw Image Analysis.
Module 4: Anti-forensic(6 Hours)
Anti-forensic Practices - Data Wiping and Shredding: Data Remanence, Degaussing, Case Study: USB Oblivion, Eraser - Trail Obfuscation: Spoofing, Data Modification, Case Study: Timestamp – Encryption, Case Study: VeraCrypt, Data Hiding: Steganography and Cryptography, Case Study: SilentEye, Anti-forensics Detection Techniques, Case Study: Stegdetect
Module 5: Network Forensics (8 Hours)
The OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Case Study: Wireshark. Web Attack Forensics: OWASP Top 10, Web Attack Tests, Intrusion Forensics, Database Forensics, Log Forensics, Content Analysis, File Metadata Analysis, Email Crimes, Phishing, Types of Phishing, Case Study: Bypassing Two-Factor Authentication, Spam, Email Forensics, Steps of an email forensic investigation

Text Books

1. Niranjan Reddy, “Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations”, Apress, 2019

Reference Books

1. Harlan Carvey, "Windows Forensic Analysis DVD Toolkit", 2 Ed., Syngress Publishing, 2009 (Module 2, Rootkits and Rootkit Detection)
2. Chris Pogue, Cory Altheide, Todd Haverkos, "UNIX and Linux Forensic Analysis DVD Toolkit",Syngress Publishing,2008 (Module 3, Live Response)
3. Gerard Johansen, "Digital forensics and incident response", 2 Ed., Packt Publishing, 2020
4. Stuart McClure, Joel Scambray, George Kurtz, "Hacking Exposed 7: Network Security Secrets & Solutions", 7 Ed., McGraw-Hill, 2012

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Introduction to Cyber Forensics**	**7 Hours**
1.1	Introduction to Cyber Forensics, Forensics Investigation Process	1
1.2	Forensic Protocol for Evidence Acquisition, Digital Forensics Standards and Guidelines	1
1.3	Digital Evidence - Cybercrime, Types of Cybercrimes	1
1.4	Recent Data Breaches - Recent Cyber security Trends	1
1.5	Case Study: Sim Swapping Fraud, ATM Card Cloning	1
1.6	Case Study: Hacking email for money, Google Nest Guard	1
1.7	Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert, Cyber Forensic Tools	1
2	**Windows Forensics**	**7 Hours**
2.1	Digital Evidence in Windows: Volatile Evidence Artifacts, Non-volatile Artifacts, Master File Table (MFT), MBR	1
2.2	Windows Registry, Event Logs, Configuration Files	1
2.3	Temporary Files, SWAP Files, Unallocated Space, File System: FAT32, NTFS	1
2.4	Rootkits and Rootkit Detection: Rootkits, Rootkit Detection	1
2.5	Case Study: Autopsy Tool	1
2.6	Malware Forensics: Types of Malwares, Malware Analysis: Static Analysis, Dynamic Analysis, Tools for Analysis	1
2.7	Case Study: Windows malware analysis of data stealing malware	1
3	**Linux Forensics**	**7 Hours**
3.1	Linux Distributions, File System, Forensic Artifacts, Special Artifacts	1
3.2	Linux Distributions Used for Forensic Analysis: Kali, DEFT	1
3.3	Challenges,Differences Between Windows and Linux from a Forensics Perspective	1
3.4	Live Response: Prepare the Target Media, Format the Drive, Gather Volatile Information, Acquiring the Image	1
3.5	Case Study: Listing Partitions,	1

3.6	Case Study: Memory Acquisition of Linux System.	1
3.7	SysScout Tool, Raw Image Analysis 1	
4	**Anti-forensic**	**6 Hours**
4.1	Anti-forensic Practices - Data Wiping and Shredding: Data Remanence, Degaussing,	1
4.2	Case Study: USB Oblivion, Eraser	1
4.3	Trail Obfuscation: Spoofing, Data Modification	1
4.4	Case Study: Timestomp	1
	Encryption, Case Study: VeraCrypt	1
4.5	Data Hiding: Steganography and Cryptography, Case Study: SilentEye	1
4.6	Anti-forensics Detection Techniques, Case Study: Stegdetect	1
5	**Network Forensics**	**8 Hours**
5.1	The OSI Model, Forensic Footprints, Seizure of Networking Devices	1
5.2	Network Forensic Artifacts ICMP Attacks, Drive-By Downloads	1
5.3	Network Forensic Analysis Tool, Case Study: Wireshark	1
5.4	Web Attack Forensics: OWASP Top 10, Web Attack Tests	1
5.5	Intrusion Forensics, Database Forensics, Log Forensics, Content Analysis, File Metadata Analysis	1
5.6	Email Crimes, Phishing, Types of Phishing,Case Study: Bypassing Two-Factor Authentication, Spam,	1
5.7	Email Forensics,Steps of an email forensic investigation	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
ITT434	CLOUD COMPUTING	PEC	2	1	0	3

Preamble: This is an elective course and the syllabus is prepared with a view to provide the students an overview on the cloud computing concepts, cloud computing technologies, computing in the cloud, cloud management and security in the cloud.

Prerequisite: Knowledge of Operating Systems and Networking

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the fundamentals of cloud computing	Level 2: Understand
CO 2	Outline virtualization and cloud computing technologies.	Level 2: Understand
CO 3	Explain the computing in cloud.	Level 2: Understand
CO 4	Describe different ways of managing cloud.	Level 2: Understand
CO 5	Summarize the security aspects of cloud	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	-	-	-	-	-	-	-	-	-	2
CO 2	3	2	-	-	-	-	-	-	-	-	-	2
CO 3	3	2	-	-	-	-	-	-	-	-	-	2
CO 4	3	2	-	-	-	-	-	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	-	-	-	-	2

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	20	20	20
Level 2: Understand	30	30	80
Level 3: Apply			
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Explain different cloud delivery models.
2. Compare public clouds and private clouds.
3. List the essential characteristics of cloud computing.

Course Outcome 2 (CO 2):

1. Explain load balancing in google cloud.
2. Describe different types of virtualization technologies.
3. Illustrate the working of Google Big table.
4. Discuss on system imaging for creating virtual machine instances.

Course Outcome 3 (CO 3):

1. Compare virtual machines and containers.
2. Explain serverless computing.
3. Give the advantages of using docker.
4. Outline the concept of microservices paradigm.

Course Outcome 4 (CO 4):

1. Find out the features that makes Eucalyptus cloud different from other private clouds.
2. Discuss the deployment plans for Eucalyptus cloud.
3. Interpret different types of SLA.
4. Illustrate Aneka cloud platform with necessary diagrams.

Course Outcome 5 (CO 5):

1. Explain the seven complementary principles that support software assurance.
2. Summarize various access control issues in cloud.
3. Outline any two acts for preserving privacy principles of cloud.
4. Discuss briefly the fundamental characteristics of cloud security design principles.

Model Question Paper

Course Code: ITT434

Course Name: CLOUD COMPUTING

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Describe the essential characteristics of cloud computing.
2. Write various benefits provided by SaaS model.
3. Explain how machine imaging helps for system portability and application instantiations in cloud.
4. Differentiate emulation, paravirtualization and full virtualization
5. Explain docker container technology.
6. Discuss microservice solution with suitable example.
7. Describe the different types of SLA.
8. Explain VM provisioning in Eucalyptus cloud.
9. List and explain the factors affecting cloud security services.
10. Give any five NIST 33 security principles.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11 a. Examine the architectural influences behind cloud computing. 8

b. Discuss the evolution of SPI framework and compare it with traditional 6

IT model.

OR

12		Write short notes on cloud service delivery models and cloud deployment models.	14
13	a.	With neat diagram explain VMware's vSphere cloud infrastructure.	6
	b.	Discuss the working and design principles of Amazon Simple Storage Service.	8

OR

14	a.	Explain various cloud computing services offered by Amazon.	8
	b.	Write the features and benefits of NIRVANIX storage delivery network.	6
15	a.	Illustrate Google's Kubernetes in detail.	7
	b.	Summarize the installation of Docker with Docker Hub.	7

OR

16	a.	Outline the setting up of Amazon EC2 container service to manage microservices based on Docker containers.	8
	b.	Examine the pros and cons of virtual machine and container approaches.	6
17	a.	Explain SLA management in cloud.	8
	b.	Describe the deployment planning process documented for Eucalyptus.	6

OR

18	a.	Explain the life cycle of SLA.	8
	b.	Illustrate Aneka architecture.	6
19	a.	Summarize the relevant cloud security design principles.	7
	b.	Discuss briefly the important areas addressed by a software system's cloud security policy.	7

OR

20	a.	Summarize the additions to be incorporated to software requirements engineering process to promote secure software.	6
	b.	Outline the privacy related acts for preserving information privacy in cloud.	8

Syllabus

Module 1: Introduction to Cloud Computing (6 Hours)
Cloud Computing Fundamentals: What is Cloud Computing, Essential Characteristics, Architectural Influences Cloud delivery modelsThe SPI Framework, Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS), Cloud deployment models, Public Clouds, Community Clouds, Private clouds, Hybrid clouds. (T1: Chapter 1,2)

Module 2: Cloud Computing Technologies (7 hours)
Using virtualization technologies, Load balancing and virtualization, Understanding hypervisors, Understanding machine imaging, Porting Applications Cloud storage- Overview, Cloud storage providers, Cloud Computing with the Titans– Google, Microsoft, Amazon, IBM. (T2: Chapter 5, T3: Chapter 3,7)
Module 3: Computing in the Cloud (8Hours)
Virtual Machines and Containers, Serverless Computing, Using and Managing Containers:- Container Basics, Docker and the Hub. Agents and Microservices: Microservices and Container Resource Managers, Managing Identity in a swarm, A simple Microservices Example, Amazon EC2 Container Service, Google's Kubernetes. (T4: Chapter 4,6,7)
Module 4:Cloud Management (6 Hours)
Building Your Own Cloud with Eucalyptus-Implementing Cloud Infrastructure Abstractions, Deployment Planning. Aneka, SLA Management in Cloud Computing-Types of SLA, Life cycle of SLA, SLA management in cloud. (T4: Chapter 12, T5: Chapter 5,16)
Module 5: Security in cloud (8 Hours)
Cloud Information Security Objectives, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements. Privacy and Compliance Risks, Threats to Infrastructure Data and Access Control, Cloud Service Provider Risks. (T1: Chapter 3,4)

Text Books

1. Cloud Security -A Comprehensive Guide to Secure Cloud Computing, Ronald L Krutz and Russell Dean Vines
2. Cloud Computing Bible, Barrie Sosinsky, Published by Wiley Publishing, 2011.
3. Cloud Computing: A Practical Approach, Anthony T. Velte Toby J. Velte, Robert Elsenpeter, 2010, The McGraw-Hill.
4. Cloud Computing for Science and Engineering, Ian Foster and Dennis B. Gannon. https://cloud4scieng.org/chapters/
5. Cloud Computing: Principles and Paradigms, RajkumarBuyya, James Broberg and Andrzej M. Goscinski,Wiley, 2011.

Reference Books

1. Kai Hwang, Geoffrey C. Fox, Jack K.Dongarra, Distributed and Cloud Computing: From parallel processing to Internet ofThings, Morgen Kauffmann 2013.
2. Jonathan Baier, Getting Started with Kubernetes: 2nd Edition, Packt publishers,2015.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Introduction to Cloud Computing**	**6 Hours**
1.1	What is Cloud Computing, Essential Characteristics,	1
1.2	Architectural Influences	1
1.3	Cloud delivery models: The SPI Framework SPI Evolution, The SPI Framework vs. the Traditional IT Model	1
1.4	Cloud Software as a Service (SaaS), Benefits of the SaaS Model	1
1.5	Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS)	1
1.6	Cloud deployment models, Community Clouds, Public clouds, Private clouds, Hybrid clouds	1
2	**Cloud Computing Technologies**	**7 Hours**
2.1	Using virtualization technologies	1
2.2	Load balancing and virtualization	1
2.3	Understanding hypervisors	1
2.4	Understanding machine imaging, Porting Applications	1
2.5	Cloud storage- Overview, Cloud storage providers	1
2.6	Cloud Computing with the Titans- Google, Microsoft	1
2.7	Cloud Computing with the Titans- Amazon, IBM	1
3	**Computing in the Cloud**	**8 Hours**
3.1	Virtual Machines and Containers, Serverless Computing	1
3.2	Using and Managing Containers: - Container Basics	1
3.3	Docker and the Hub	1
3.4	Agents and Microservices: Microservices and Container Resource Managers	1
3.5	Managing Identity in a swarm, A simple Microservices Example	1
3.6	Amazon EC2 Container Service	2
3.7	Google's Kubernetes	1
4	**Cloud Management**	**6 Hours**
4.1	Building Your Own Cloud with Eucalyptus-Implementing Cloud Infrastructure Abstractions	1
4.2	Deployment Planning	1

4.3	Aneka	1
4.4	SLA Management in Cloud Computing:- Types of SLA	1
4.5	Life cycle of SLA	1
4.6	SLA management in cloud	1
5	**Security in the cloud**	**8 Hours**
5.1	Cloud Information Security Objectives, Cloud Security Services	1
5.2	Relevant Cloud Security Design Principles	1
5.3	Secure Cloud Software Requirements	2
5.4	Privacy and Compliance Risks	1
5.5	Threats to Infrastructure Data and Access Control	2
5.6	Cloud Service Provider Risks	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT444	DATA MINING AND WAREHOUSING	PEC	2	1	0	3

Preamble: This course introduces students to understand the data mining concepts and various data pre-processing techniques, analyze various data mining algorithms for finding hidden and interesting patterns in data, also to learn about the fundamental concepts of data warehouse architectures**.**

Prerequisite: ITT306 Data Science

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Understand the basic concepts in data mining and the data warehouse architectures.	Level 2: Understand
CO 2	Identify suitable preprocessing techniques to improve the quality of data and the ease of the mining process.	Level 3: Understand
CO 3	Use frequent pattern and association rule mining techniques to identify associations among objects.	Level 3: Apply
CO 4	Implement appropriate classification and clustering techniques to solve real life complex problems.	Level 3: Apply
CO 5	Demonstrate advanced data mining techniques and applications.	Level 2: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	2	2	1	1	-	-	-	-	-	-	-	1
CO 3	2	2	2	1	-	-	-	-	-	-	-	1
CO 4	2	2	2	1	-	-	-	-	-	-	-	1
CO 5	2	2	2	-	2	-	-	-	-	-	-	1

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	10	10	20
Level 2: Understand	30	20	50
Level 3: Apply	10	20	30
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Describe the various steps in knowledge discovery process with necessary diagram
2. Distinguish OLTP and OLAP. Clearly bring out the advantages of OLAP.
3. Write a note on various components of Data Warehouse.

Course Outcome 2 (CO 2):

1. List out and explain the major tasks involved in data preprocessing.
2. With Suitable example explain the purpose binning.
3. Describe in detail the various normalization techniques used in data transformation.

Course Outcome 3 (CO 3):

1. With example explain Apriori frequent pattern mining algorithm.

2. Identify and describe issues regarding preprocessing the data for classification and prediction.

3. Draw a multi-layer feed forward neural network and clearly state the role of each element in classification.

Course Outcome 4 (CO 4):

1. What is cluster analysis? Identify the typical requirements for clustering as a data mining tool.
2. Explain in detail about Density based clustering technique using DBSCAN algorithm.
3. Demonstrate the distance based outlier detection approaches.

Course Outcome 5 (CO 5):

1. Present the various approaches in similarity based retrieval in image databases.
2. Write a note on data mining tool Rapid Miner.
3. Analyze the three popular text mining approaches based on the kinds of data they take as input.

Model Question Paper

Course Code: ITT444

Course Name: DATA MINING AND WAREHOUSING

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Define Data Mining. Explain the architecture of a typical data mining system.
2. Compare and contrast data mart and data warehouse.
3. Identify the necessity of dimensionality reduction in data mining.
4. Identify the methods that can handle missing data in databases. Illustrate with suitable example.
5. Describe the commonly used four techniques for assessing the performance of a classifier.
6. Discuss the different ways to combine multiple base-learners.
7. Describe any one of the grid based clustering approaches.
8. What is an Outlier? How outlier analysis improves the performance of clustering?
9. Identify the challenges for efficient and effective knowledge discovery and uses of resources on internet
10. Briefly explain the various web usage mining approaches.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11 Draw the three-tier data warehousing architecture and explain the functionalities of each layer. 14

OR

12 Show the different OLAP schema with suitable example and explain each model. 14

13 Describe in detail with suitable examples the various numerosity reduction techniques that can be applied to obtain a reduced representation of the data set in data mining. 14

OR

14 Categorize the various data discretization techniques and explain each category techniques in detail. 14

15 Generate association rules using the Apriori algorithm on the grocery store example given below with support threshold s=33.34% and confidence threshold c=60%. Show the candidate and frequent itemsets for each database scan. Enumerate all the final frequent itemsets. Also indicate the association rules that are generated and highlight the strong ones, sort them by confidence. 14

Transaction ID	Items
T1	HotDogs,Buns,Ketchup
T2	Hotdogs, Buns
T3	HotDogs,Coke,Chips
T4	Chips,Coke
T5	Chips,Ketchup
T6	HotDogs,Coke,Chips

OR

16 a. Suppose a computer program for recognizing dogs in photographs identifies eight dogs in a picture containing 12 dogs and some cats. Of the eight dogs identified, five actually are dogs while the rest are cats. Compute the precision and recall of the computer program. 5

b. Describe neural network training process using back propagation algorithm. 9

17 Using k-means algorithm, cluster the following 7samples into 3 clusters: A1=(2,10), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), Suppose that the initial seeds (centers of each cluster) are A1, A4 and A7. Run the k-means algorithm for 1 epoch. At the end of this epoch shows:

a. The new clusters;
b. The centers of the new clusters; 14
c. Draw a 10 by 10 space with all the 7 points and show the clusters after the first epoch and the new centroids.
d. How many more iterations are needed to converge?

OR

18 a) Give one clustering application example for each of the following cases:

ii. An application that uses clustering as a major data mining function.
iii. An application that uses clustering as a pre-processing tool for data preparation for other data mining tasks. 4 10

b) With necessary diagram describe the various approaches for effective clustering of high-dimensional data.

19 Describe the steps involved in building classifier models in Weka. 14

OR

20 a What is text data mining? Give the differences between text mining and information retrieval. 10

b. Describe briefly CRM Applications in data mining. 4

Syllabus

Module 1: Overview of data mining and data warehouse architectures (7 Hours)
Data mining Introduction –Types of data to be mined - Data mining functionalities - Classification of Data mining system- Data mining task primitives - Major issues in Data mining Data Warehouse and OLAP Technology -Multidimensional data model -Data Warehouse Architecture.
Module 2: Data Pre-processing Techniques (6Hours)
Data pre-processing:– Need of data pre-processing - Descriptive Data summarization - Data cleaning - Data integration and transformation -Data reduction -Data discretization and Concept Hierarchy Generation.
Module 3: Association Rule Mining and Classification & Prediction (8 Hours)
Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods — Mining Various Kinds of Association Rules — Association Mining to Correlation Analysis.Sequential Rule Mining. Classification and Prediction: - Issues Regarding Classification and Prediction - Rule Based Classification — Classification by Back propagation -k-Nearest Neighbor Classifier - Ensemble methods - Classifier Accuracy: confusion matrix, ROC curve - Associative Classification.
Module 4:Cluster and Outlier Analysis (7 Hours)
Cluster Analysis: - Types of Data in Cluster Analysis — Categorization of Major Clustering Methods, Partition Based Clustering methods - Density-Based Methods — Grid- Based Methods — Model-Based Clustering Methods — Clustering High-Dimensional Data — Constraint-Based Cluster Analysis — Outlier Analysis.
Module 5: Advanced Data Mining Techniques and Tools (7 Hours)
Advanced Data Mining Techniques: Multimedia Data Mining —Text Mining - Text Data Analysis and Information Retrieval, Text mining approaches - Web Mining- Web Content Mining, Web Structure Mining, Web Usage Mining. CRM Applications and Data mining - Practical Data Mining Tools: Weka, RapidMiner.

Text Books

1. Jaiwei Han, Micheline Kamber, Data Mining Concepts and Techniques, Elsevier, 2nd Edition, 2006.
2. AlexBerson and Stephen J. Smith, Data Warehousing, Data Mining & OLAP,TataMcGraw Hill Edition, Tenth Reprint 2007.

Reference Books

1. Pualraj Ponnaiah, Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals, Wiley, 2nd edition, 2001.
2. Dunham M H, Data Mining: Introductory and Advanced Topics, Pearson Education, New Delhi, 2003.
3. Ian Witten, Eibe Frank, Data Mining; Practical Machine Learning Tools and Techniques, 3rd edition, Morgan Kaufmann, 2011.
4. Pang-Ning Tan and Michael Steinbach, Introduction to Data Mining, Addison Wesley,2nd edition, 2006.
5. M Sudeep Elayidom, Data Mining and Warehousing, Cengage Learning India Pvt. Ltd,1stEdition, 2015.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Overview of data mining anddata warehouse architectures**	**7 Hours**
1.1	Data mining Introduction, Types of data to be mined	1
1.2	Data mining functionalities	1
1.3	Classification of Data mining system	1
1.4	Data mining task primitives, Major issues in Data mining	1
1.5	Data Warehouse and OLAP Technology	1
1.6	Multidimensional data model	1
1.7	Data Warehouse Architecture	1
2	**Data Pre-processing Techniques**	**6 Hours**
2.1	Data pre-processing-: Need of data pre-processing	1
2.2	Descriptive data summarization	1
2.3	Data cleaning	1
2.4	Data integration and transformation	1
2.5	Data reduction	1
2.6	Data discretization and Concept Hierarchy Generation.	1
3	**Association Rule Mining and Classification & Prediction**	**8 Hours**
3.1	Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods	1

3.2	Mining Various Kinds of Association Rules, Association Mining to Correlation Analysis	1
3.3	Sequential Rule Mining	1
3.4	Classification and Prediction: - Issues Regarding Classification and Prediction, Rule Based Classification	1
3.5	Classification by Back propagation	1
3.6	k-Nearest Neighbor Classifier	1
3.7	Ensemble methods, Classifier Accuracy: confusion matrix, ROC curve	1
3.8	Associative Classification	1
4	**Cluster and Outlier Analysis**	**7 Hours**
4.1	Cluster Analysis: - Types of Data in Cluster Analysis — A Categorization of Major Clustering Methods	1
4.2	Partition Based Clustering methods	1
4.3	Density-Based Methods	1
4.4	Grid-Based Methods, Model-Based Clustering Methods	1
4.5	Clustering High-Dimensional Data	1
4.6	Constraint-Based Cluster Analysis	1
4.7	Outlier Analysis	1
5	**Advanced Data Mining Techniques and Tools**	**7 Hours**
5.1	Multimedia Data Mining	1
5.2	Text Mining - Text Data Analysis and Information Retrieval	1
5.3	Text mining approaches	1
5.4	Web Content Mining, Web Structure Mining, Web Usage Mining	1
5.5	CRM Applications and Data mining	1
5.6	Practical Data Mining Tools: Weka	1
5.7	RapidMiner	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT454	SEARCH ENGINE OPTIMISATION	PEC	2	1	0	3

Preamble: The syllabus is prepared with a view to equip the Engineering Graduates to learn basic concepts in search engine optimization and various search engine optimization algorithms.

Prerequisite: Nil

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the basics of search engine optimization	Level 2: Understand
CO 2	Identify SEO planning strategies.	Level 2: Understand
CO 3	Make use of SEO algorithm.	Level 3: Apply
CO 4	Describe keyword research	Level 2: Understand
CO 5	Explain the concept of content marketing.	Level 2: Understand
CO 6	Identify evaluation metrics for SEO techniques.	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	-	-	-	-	-	-	-	-	-	1
CO 2	2	2	-	-	-	-	-	-	-	-	-	1
CO 3	3	2	-	-	-	-	-	-	-	-	-	1
CO 4	2	-	-	-	-	-	-	-	-	-	-	1
CO 5	2	-	-	-	-	-	-	-	-	-	-	1
CO 6	3	1										1

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	10	10	10
Level 2: Understand	40	30	70
Level 3: Apply		10	20
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Explain search engine optimization in detail
2. Describe algorithm based ranking system
3. Illustrate the use of knowledge graphs in SEO
4. Discuss ranking factors used for optimization

Course Outcome 2 (CO 2):

1. Illustrate SEO strategy plan.
2. List any three types of Search Intents in SEO.
3. Explain the Strategic Goals of SEO Practitioners.

Course Outcome 3 (CO 3):

1. Discuss log file tracking in detail
2. Explain in detail the process of auditing an existing site.
3. Outline SEO problems that can be identified by auditing an existing site
4. List the technology and structural decisions in developing SEO techniques.

Course Outcome 4 (CO 4):

1. Describe how keyword research can be done.
2. Explain the process of identifying terms from relevant web pages.
3. Why some keywords do works better than other keywords in SEO?

Course Outcome 5 (CO 5):

1. What is content marketing? Explain with examples.
2. Explain different ways of doing content marketing.
3. Write and Explain Page Rank algorithm.
4. Describe SEO improvement by optimizing user experience.

Model Question Paper

Course Code: ITT454

Course Name: SEARCH ENGINE OPTIMISATION

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Explain search engine.
2. Explain the need for Search Engine Optimization.
3. Illustrate the use of search intents.
4. List and explain the different types of search engine queries.
5. Give the reasons for search engine keyword demand with diagram.
6. Explain cross link relevant content. Give examples
7. Explain the significance of keyword review.
8. What do you mean by Keyword Cannibalization?
9. Briefly explain how links are earned in content marketing.
10. Outline the influence of links in page ranking.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11	a.	Explain with example layout of google search results	9
	b.	Discuss how crawling, indexing and ranking enables efficient SEO.	5
		OR	
12	a.	Explain document analysis and semantic connectivity in detail	10

	b.	Discuss the type of contents that cannot be captured by search engines.	4
13	a.	Give the business factors that impact SEO query. Explain.	10
	b.	Explain SWOT analysis	4
		OR	
14		Select any specific application in real life and illustrate how we can define SEO technique for that application	14
15	a.	Describe the importance of planning in SEO implementation	10
	b.	Which are the technology decisions to be taken in SEO implementation?	4
		OR	
16		Select any specific application in real life and illustrate how we can implement SEO technique for that application.	14
17	a.	Describe in detail tools used for keyword research.	12
	b.	How Bing research keyword is useful?	2
		OR	
18		Explain Experian Hitwise in detail	14
19		Give the roles of memes in marketing campaigns?	14
		OR	
20	a.	Explain in detail the process of content marketing	7
	b.	Describe competitive and diagnostics search metrics.	7

Syllabus

Module 1: Search Engine Basics (6 Hours)
Understanding search engine results, Algorithm-based ranking system- Crawling, Indexing and ranking. Knowledge graph, Analysing ranking factors, Determining searcher intent and delivering relevant, Fresh content
Module 2: SEO Planning (8 Hours)
Strategic goals, Understanding search engine traffic and visitor intent, Developing an SEO plan prior to site development, Understanding your audience and finding your niche, SEO for raw traffic, Advanced methods for planning and evaluation
Module 3:SEO Implementation (8 Hours)
First stages: The importance of planning, Identifying the site development process and players, Development platform and information architecture, Auditing an existing site to identify SEO problems, Identifying current server statistics software and gaining access, Advanced methods for planning and evaluation-Case study-Real life application.
Module 4:Keyword Research (6 Hours)
The theory behind keyword research, Traditional approaches: domain expertise and site content analysis, Keyword research options, Leveraging the long tail of keyword demand
Module 5:Content Marketing (7 Hours)
Content Marketing: Introduction, Choosing the right content marketing strategy, Types of content marketing campaigns, Building an audience, Relationships and outreach. Tracking Results and Measuring Success-importance, measuring search traffic, Competitive and Diagnostic Search Metrics.

Text Books

1. Eric Enge, Stephan Spencer, and Jessie C. Stricchiola,The Art of SEO Mastering Search Engine Optimization, O'Reilly, Third edition, 2015.

Reference Books

1. Jerri L. Ledford, SEO: Search Engine Optimization Bible, Wiley India, 2nd Edition, 2009
2. John I Jerkovic, SEO Warrior: Essential Techniques for Increasing Web Visibility, O'Reilly Media, 2009

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Search Engine Basics**	**6 Hours**
1.1	Understanding Search Engine Results	1
1.2	Algorithm-based Ranking System	1
1.3	Crawling, Indexing, Ranking.	2
1.4	Knowledge Graph	1
1.5	Analysing Ranking factors, Determining Searcher Intent and Delivering Relevant, Fresh Content	1
2	**SEO Planning**	**8 Hours**
2.1	Understanding Search Engine Traffic, Visitor Intent	1
2.2	Developing an SEO Plan Prior to Site Development	2
2.3	Understanding Your Audience, Finding Your Niche	2
2.4	SEO for Raw Traffic	2
2.5	Advanced Methods for Planning and Evaluation	1
3	**SEO Implementation**	**8 Hours**
3.1	First Stages: The Importance of Planning	1
3.2	Identifying the Site Development Process and Players	2
3.3	Development Platform and Information Architecture	1
3.4	Auditing an Existing Site to Identify SEO Problems	1
3.5	Identifying Current Server Statistics Software and Gaining Access, Advanced Methods for Planning and Evaluation	1
3.6	Case Study	2
4	**Keyword Research**	**6 Hours**
4.1	The Theory Behind Keyword Research	1
4.2	Traditional Approaches: Domain Expertise and Site Content Analysis	1

4.3	Keyword Research Options	2
4.4	Leveraging the Long Tail of Keyword Demand 2	
5	**Content Marketing**	**7Hours**
5.1	Introduction	1
5.2	Choosing the right content marketing strategy	1
5.3	Types of Content Marketing Campaigns	1
5.4	Building an audience, Relationships and outreach	1
5.5	Tracking Results and Measuring Success-importance, measuring search traffic	1
5.6	Competitive and Diagnostic Search Metrics	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT464	COMPUTER GRAPHICS	PEC	2	1	0	3

Preamble: Computer Graphics is a graduate – level preliminary course to introduce the necessary background, the basic algorithms, and the applications of computer graphics. The course is intended to deliver the fundamental concepts of Graphics Systems, Display Technologies, 2D Geometric Transformations, 2D Clipping, Visible Surface Detection Methods and Colour Models.

Prerequisite: Nil

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Illustrate line drawing and circle generation algorithms.	Level 3:Apply
CO 2	Explain the techniques used for various display technologies.	Level 2: Understand
CO 3	Illustrate the matrix corresponding to various 2D transformations.	Level 3: Apply
CO 4	Explain 2D line clipping and polygon clipping algorithms and 3D transformations.	Level 2: Understand
CO 5	Describe various visible surface detection methods and colour models.	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	1	-	-	-	-	-	-	-	-
CO 2	2	2	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	2	1	-	-	-	-	-	-	-	-
CO 4	2	2	2	-	-	-	-	-	-	-	-	-
CO 5	3	2	2	-	-	-	-	-	-	-	-	-

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	20	20	30
Level 2: Understand	20	20	50
Level 3: Apply	10	10	20
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Derive the decision parameter in Bresenham's line drawing algorithm.
2. Write midpoint circle drawing algorithm. Illustrate it with radius=10 which is centred at the point (5,5).
3. Differentiate between raster scan and random scan systems with neat diagrams.

Course Outcome 2 (CO 2):

1. Differentiate between LCD and PLASMA displays.
2. Explain OLED displays. How it differs from LED.

3. Explain the working principle behind AMOLED.

Course Outcome 3 (CO 3):

1. Translate the square ABCD whose co-ordinates are A (0,0), B (3,0), C (3,3) and D (0,3) by 2 units in both directions and then scale it by 1.5 units in x- direction and 0.5 units in y-direction.
2. Draw a triangle A (5,5), B (10,5), C (5,15) and do the following transformation on the triangle: Translate the triangle by 3 in x – direction and 4 in y-direction, increase the size of the triangle to double of it and rotate the triangle by 90 degrees.
3. Explain homogeneous matrix representation of 2D transformation.

Course Outcome 4 (CO 4):

1. Describe Sutherland – Hodgeman Polygon Clipping algorithm with an example.
2. What is clipping? Describe Cohen Sutherland line clipping algorithm.
3. How rotation is working in three- dimensional transformation?

Course Outcome 5 (CO 5):

1. Explain Z-buffer algorithm with necessary equations.
2. Describe the different methods to detect Back Faces with the help of equations.
3. Discuss HSV colour model?

Model Question Paper

Course Code: ITT464
Course Name: COMPUTER GRAPHICS

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Differentiate between raster scan and random scan systems.
2. Compare DDA line drawing algorithm with Bresenham's algorithm.
3. Write short notes on E-Paper displays.
4. What are the advantages and disadvantages of LCD?
5. Show that transformation matrix for reflection about y=x followed by reflection about y- axis is equivalent to rotation about origin by 90 degrees.
6. Define homogeneous coordinates.
7. Write the basic 3D transformation matrices.
8. Define clipping. What are the different types of clipping?
9. What is RGB colour model?
10. Which are the two different fields in A – Buffer method?

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11	a.	Illustrate Bresenham's line drawing algorithm with endpoints (20,10) and(30,18).	7
	b.	Derive the decision parameter in midpoint circle drawing algorithm and write the algorithm.	7
		OR	
12	a.	Using DDA algorithm rasterize the line from (0,0) to (4,6) and plot the line.	9
	b.	Write a boundary fill procedure to fill an 8 connected region in filled area primitives.	5
13	a.	With neat diagram explain working principle of cathode ray tube in display devices.	9
	b.	What is the working principle behind the plasma panel?	5
		OR	
14	a.	Differentiate LED and OLED.	7
	b.	Describe the working principle of AMOLED along with their advantages and disadvantages.	7
15	a.	Consider the square A (1,0), B (0,0), C (0,1), D (1,1). Rotate the square ABCD by 45 degree clockwise about fixed-point A (1,0). Write composite transformation matrix and draw resulting figure.	8
	b.	What is a shearing transformation? Give the transformation matrices for x-direction and y-direction shear.	6
		OR	
16	a.	A triangle is defined by matrix $\begin{matrix} 2 & 4 & 4 \\ 2 & 2 & 4 \end{matrix}$ Find the transformed coordinates after the following transformation (1)90^o rotation about origin (2) Shearing along x axis by 1 unit	8
	b.	Translate the square ABCD whose co-ordinates are A (0,0), B (3,0), C (3,3) and D (0,3) by2 units in both directions and then scale it by 1.5 units in x- direction and 0.5 units in y- direction.	6
17	a.	How rotation is working in the x-axis, y-axis and z-axis in the three dimensional transformation?	7
	b.	Explain Sutherland – Hodgeman polygon clipping algorithm with suitable example.	7
		OR	
18	a.	Describe Cohen Sutherland line clipping algorithm with an example.	7
	b.	Explain 3D geometric transformation in detail.	7
19	a.	Explain Scan line algorithm with a neat diagram.	7
	b.	What is visible surface detection? Explain Back face removal algorithm.	7
		OR	
20	a	Discuss about Painter's algorithm.	7
	b.	Explain any two colour models.	7

Syllabus

Module 1: Graphics Systems (8 Hours)
Raster Scan & Random Scan systems. Output Primitives – Line Drawing Algorithms (DDA, Bresenham), Bresenham's circle generation algorithm. Filled Area Primitives – Scan Fill, Flood Fill, Boundary Fill. Inside outside tests.
Module 2: Display Technologies(6 Hours)
Working principle behind CRT, LCD, Plasma, LED, OLED, AMOLED, E-Paper displays.
Module 3: 2-Dimensional Geometric Transformations (8 Hours)
Basic Transformations, Reflection & Shear, Homogenous Matrix representation of transformations, Composite Transformations.
Module 4:2-D Clipping&3-Dimensional Geometric Transformations (6 Hours)
2-D Clipping: Point Clipping, Cohen-Sutherland Line Clipping Algorithm, Sutherland-Hodgeman Polygon Clipping Algorithm. 3-Dimensional Geometric Transformations: Basic transformations, Composite 3D transformations (Basics only)
Module 5: Visible Surface Detection Methods & Colour Models (7 Hours)
Visible Surface Detection Methods: Back Face Detection, Depth Buffer, A-Buffer, Scan line, Depth sorting methods. Colour Models: RGB Model, CMY Model, HSV Model

Text Books

1. Donald Hearn, Pauline Baker, Computer Graphics – C Version, Pearson Education, 2nd Edition,2002
2. Amarendra N' Sinha and Arun D Udai, "Computer Graphics", The McGraw-Hill Companies.

Reference Books

1. David F. Rogers, Procedural Elements for Computer Graphics, Tata McGraw-Hill.
2. Foley, van Dam, Feiner & Hughes, Computer Graphics Principles & Practice, Pearson Education.
3. William M. Newman, Robert F. Sproull, Principles of Interactive Computer Graphics, Tata McGraw-Hill.
4. David F. Rogers, J. Alan Adams, Mathematical Elements for Computer Graphics, Tata McGraw- Hill.
5. https://poli.cs.vsb.cz/edu/apps/down/disp_overview.pdf
6. https://en.wikipedia.org/wiki/AMOLED

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Graphics Systems**	**8 Hours**
1.1	Raster Scan & Random Scan systems	1
1.2	Output Primitives – Line Drawing Algorithms	1
1.3	DDA	1
1.4	Bresenham's line drawing algorithm	2
1.5	Bresenham's circle generation algorithm	2
1.6	Filled area primitives (Scan Fill, Flood Fill, Inside outside tests)	1
2	**Display Technologies**	**6 Hours**
2.1	Working principle behind CRT	1
2.2	LCD	1
2.3	Plasma	1
2.4	LED, OLED	1
2.5	AMOLED	1
2.6	E-Paper displays.	1
3	**2-Dimensional Geometric Transformations**	**8 Hours**
3.1	Basic Transformations	2
3.2	Reflection & Shear	2
3.3	Homogenous Matrix representation of transformations	2
3.4	Composite Transformations	2
4	**2-D Clipping&3-Dimensional Geometric Transformations**	**6 Hours**
4.1	Point Clipping	1
4.2	Cohen-Sutherland Line Clipping Algorithm	1
4.3	Sutherland-Hodgeman Polygon Clipping Algorithm	1
4.4	3-Dimensional Geometric Transformations: Basic transformations	2
4.5	Composite 3D transformations (Basics only)	1
5	**Visible Surface Detection Methods&Colour Models**	**7 Hours**
5.1	Back Face Detection	1
5.2	Depth Buffer, A-Buffer	1
5.3	A-Buffer	1
5.4	Scan line	1
5.5	Depth sorting methods.	1
5.6	Colour Models	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
ITT474	BLOCK CHAIN TECHNOLOGY	PEC	2	1	0	3

Preamble: The purpose of this course is to introduce the foundation of blockchain technology. The course introduces the cryptographic principles behind blockchain and helps the students understand concepts like consensus, crypto-currency, smart contracts, use cases etc. The course enables students to develop simple decentralized applications using blockchain networks such as Ethereum.

Prerequisite: ITT201 Data Structures, ITT303 Operating System Concepts

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the cryptographic building blocks of block chain Technology	Level 2: Understand
CO 2	Explain the fundamental concepts of block chain Technology	Level 2: Understand
CO 3	Summarize the classification of consensus algorithms	Level 2: Understand
CO 4	Explain the concepts of first decentralized crypto-currency Bitcoin	Level 2: Understand
CO 5	Explain the use of smart contracts and its use cases.	Level 2: Understand
CO 6	Develop simple applications using Solidity language on Ethereum platform.	Level 3: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	-	-	-	-	-	-	-	-	-	1
CO 2	2	2	-	-	-	-	-	-	-	-	-	1
CO 3	2	2	-	-	-	-	-	-	-	-	-	1
CO 4	2	2	-	-	-	-	-	-	-	-	-	1
CO 5	2	2	-	-	-	-	-	-	-	-	-	1
CO6	3	2	2	2	-	-	-	-	-	-	-	2

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	**2**	
Level 1: Remember	10	10	20
Level 2: Understand	40	25	70
Level 3: Apply		15	20
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Distinguish between Symmetric cryptography and asymmetric cryptography.
2. Explain Cryptographic hash functions and its applications

Course Outcome 2 (CO 2):

1. Categorize consensus mechanism used in block chain.
2. Define Block chain. Explain how decentralization of computing or processing power is achieved by a block chain.

Course Outcome 3 (CO 3):

1. Explain how Proof of Stake can achieve consensus among peers.

2. Explain the working of Raft protocol.

Course Outcome 4 (CO 4):

1. Describe the use of genesis block.
2. Explain the mining algorithm used in bitcoin.

Course Outcome 5 (CO 5):

1. Illustrate how block chain technology can be used in supply chain management.
2. What are oracles in a block chain ecosystem? Explain the generic data flow from a smart contract to an oracle.

Course Outcome 6 (CO 6):

1. Develop a smart contract for voting process. In this application, delegated voting is allowed and the counting is automatic and completely transparent at the same time.
2. Develop a smart contract for auction process. The contract should be a blind auction where it is not possible to see the actual bid until the bidding period ends.

Model Question Paper

Course Code: ITT474
Course Name: BLOCK CHAIN TECHNOLOGY

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Discuss the role of hash tables in block chain.
2. Illustrate asymmetric cryptography.
3. Illustrate the block chain based decentralized system
4. Explain how Proof of Stake can achieve consensus among peers.
5. If your block chain network has 5 Byzantine nodes, what is the minimum number of nodes that are required to ensure Byzantine fault tolerance using PBFT protocol
6. How are transactions verified in a Bitcoin network?
7. Explain how smart contracts can be used for enforcing agreements between parties in the form of business logic.
8. Explain the concept of block chain-based digital identity cards.
9. Explain error handling in Solidity language.
10. With the help of a figure show the relationship between the transaction, transaction trie, and block header in Ethereum

Part B

Answer all questions. Each question carries 14 marks (5*14=70 Marks)

11.a.	Explain the importance of Cryptography in Block chain.	9
b.	Explain how hash functions are used to build Merkle trees in block chain.	5
	OR	
12.a.	Explain public and private keys. Perform encryption and decryption using RSA for p=3, q=11, e= 7 and M=5	7
b.	Explain Cryptographic hash functions and its importance in Block chain.	7
13.a.	Illustrate and explain how block chain works using a neat diagram.	7
b.	Explain the benefits, features and limitations of block chain.	7
	OR	
14.a.	Explain consensus mechanisms used in block chain. List out any six consensus algorithms used in the context of block chain.	7
b.	Define block chain. Explain how decentralization of computing or processing power is achieved by a block chain	7
15.a.	Explain and illustrate how Paxos protocol can be used to achieve consensus	7
b.	Show how Practical Byzantine Fault Tolerance can achieve consensus in the presence of Byzantine faults.	7
	OR	
16.a.	Describe the various fields that make up a transaction in Bitcoin.	7
b.	What is the role of a Bitcoin miner? Explain the mining algorithm used in Bitcoin with the help of a flowchart.	7
17.a.	Illustrate how block chain technology can be implemented in finance sector.	7
b.	Discuss oracles in a block chain ecosystem. Explain the generic data flow from a smart contract to an oracle.	7
	OR	
18.a.	Explain the design process of decentralized applications with diagrams.	7
b.	Explain the use of block chain technology in supply chain management.	7
19.a.	Using Solidity language, create a simple bank contract that allows a user to deposit, withdraw and view balance.	7
b.	Define block difficulty. Explain how block difficulty is adjusted in Ethereum block chain network.	7
	OR	
20.a.	Using Solidity language, create a simple voting smart contract where a Chair-person will give the right to vote to each address individually.	7
b.	Explain the concept of Gas in Ethereum. Explain how transaction cost can be	7

calculated in an Ethereum block chainnetwork.

Syllabus

Module 1: Fundamentals of Cryptography (7 Hours)
Introduction to Cryptography, Symmetric cryptography – AES. Asymmetric cryptography – RSA. Cryptographic hash functions-Applications of cryptographic hash functions – Merkle trees, Distributed hash tables.
Module 2: Fundamentals of Block chain Technology (6 Hours)
Block chain – Definition, architecture, elements of block chain, benefits and limitations, types of block chain. Consensus – definition, types, consensus in block chain. Decentralization – Decentralization using block chain, Methods of decentralization, Routes to decentralization, Block chain and full ecosystem decentralization.
Module 3: Consensus Algorithms and Bitcoin (8 Hours)
Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine fault-tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT), Proof of work (PoW), Proof of stake (PoS), Types of PoS. Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses. Transactions – Lifecycle, coinbase transactions, transaction validation. Block chain – The genesis block. Mining – Tasks of miners, mining algorithm, hash rate. Wallets – Types of wallets.
Module 4:Smart Contracts and Use cases (7 Hours)
Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts. Decentralization terminology – Decentralized applications, Decentralized Autonomous Organizations. Use cases of Block chain technology – Government, Health care, Finance, Supply chain management. Block chain and allied technologies – Block chain and Cloud Computing, Block chain and Artificial Intelligence.
Module 5: Ethereum and Solidity 7 Hours)
Ethereum – The Ethereum network. Components of the Ethereum ecosystem – Keys and addresses, Accounts, Transactions and messages. The Ethereum Virtual Machine, Blocks and block chain. The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types, control structures, events, inheritance, libraries, functions, error handling. Smart contracts Case study: Voting, Auction

Text Books

1. Imran Bashir, Mastering Block chain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Packt Publishing, Third edition, 2020.

Reference Books

1. Ritesh Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and block chain, Packt Publishing, First edition, 2018.
2. Kumar Saurabh, Ashutosh Saxena, Blockchain Technology: Concepts and Applications, First Edition, Wiley Publications, First edition, 2020.
3. Chandramouli Subramanian, Asha A George, et al, Blockchain Technology, Universities Press (India) Pvt. Ltd, First edition, August 2020.
4. Lorne Lantz, Daniel Cawrey, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'Reilly Media, First edition, 2020.
5. Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, First edition, 2018.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Fundamentals of Cryptography and Hash functions**	**7 Hours**
1.1	Introduction to cryptography	1
1.2	Symmetric cryptography, AES	1
1.3	Asymmetric cryptography, RSA	1
1.4	Cryptographic hash functions	1
1.5	Applications of cryptographic hash functions	1
1.6	Merkle trees	1
1.7	Distributed hash tables	1
2	**Fundamentals of Block chain Technology**	**6 Hours**
2.1	Block chain – definition and architecture	1
2.2	Elements of block chain.	1
2.3	Block chain – benefits and limitations, types.	1
2.4	Consensus – definition, types, consensus in block chain	1
2.5	Decentralization using block chain, Methods of decentralization	1
2.6	Routes to decentralization, Block chain and full ecosystem decentralization	1
3	**Consensus Algorithms and Bitcoin**	**7 Hours**
3.1	Consensus Algorithms – Crash fault-tolerance (CFT) algorithms – Paxos, Raft (working is expected).	1

3.2	Byzantine fault-tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT) (working is expected).	1
3.3	Proof of Work (POW), Proof of Stake(POS), Types of POS	1
3.4	Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses.	1
3.5	Transactions – Lifecycle, coinbase transactions, transaction validation	1
3.6	Block chain – The genesis block. Mining – Tasks of miners	1
3.7	Mining – mining algorithm, hash rate. Wallets – Types of wallets.	1
4	**Smart Contracts and Use cases**	**6 Hours**
4.1	Smart Contracts – Definition, Smart contract templates	1
4.2	Oracles, Types of oracles, Deploying smart contracts.	1
4.3	Decentralization terminology –Decentralized applications, Decentralized Autonomous Organizations.	1
4.4	Use cases of Block chain technology – Government, Health care.	1
4.5	Use cases of Block chain technology – Finance, Supply chain management.	1
4.6	Block chain and Allied Technologies – Block chain and Cloud Computing, Block chain and Artificial Intelligence.	1
5	**Ethereum and Solidity**	**9 Hours**
5.1	Ethereum - The Ethereum network, Components of the Ethereum ecosystem – Keys and addresses, Accounts	1
5.2	Components of the Ethereum ecosystem – Transactions and messages	1
5.3	The Ethereum Virtual Machine	1
5.4	Ethereum Blocks and block chain	1
5.5	The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types	1
5.6	The Solidity language – control structures, events, inheritance, libraries	1
5.7	The Solidity language – functions, error handling.	1
5.8	Smart contracts Case study: Voting.	1

SEMESTER VIII

PROGRAM ELECTIVE IV

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT416	SOCIAL NETWORKS ANALYSIS	PEC	2	1	0	3

Preamble: This course gives a basic understanding of what social network analysis is and how it can be applied. Topics covered include network structure and methods for social network analysis, link analysis and network community detection, information propagation on the web and some applications.

Prerequisite: NIL

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

CO No.	Course Outcome (CO)	Bloom's Category
CO 1	Discuss the basic notation and terminology used in social network analysis	Level 2: Understand
CO 2	Compare and interpret social network structure, size and its connectivity pattern.	Level 2: Understand
CO 3	Discover community structure in complex network using statistical techniques	Level 3: Apply
CO 4	Apply link prediction techniques to discover new links in the social network	Level 3: Apply
CO 5	Describe influence in social media, perform recommendations and analyze behavior	Level 2: Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2										
CO 2	2	1	1	1								
CO 3	2	1	1	1								1
CO 4	2	1	1	1								1
CO 5	2	1	1	1								1

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	35	25	60
Apply	10	20	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14marks.

Course Level Assessment Questions

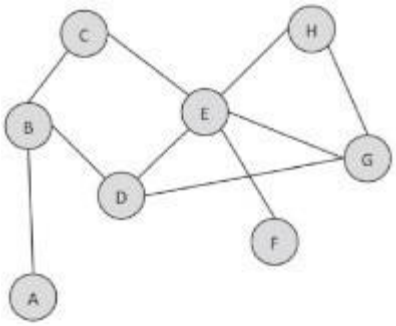
Course Outcome 1 (CO1):

List the 15 people you are closest to. Turn this list into a network by listing all the connections between these people

1. Is your network directed or undirected?
2. What do the edges represent (friendship, family relationship, close relationships, acquaintances, etc.)?

Course Outcome 2 (CO2):

Consider the following graph



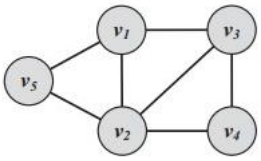
1. What is the degree distribution for this graph?
2. What is the density of the graph?
3. Which node has the highest closeness centrality?
4. Which nodes have the highest degree centrality?
5. What is the cohesion of the graph

Course Outcome 3 (CO3):

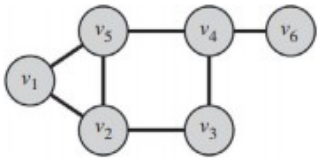
1. Explain the Usage of Girvan and Newman's divisive algorithm as part of agglomerative/Division Algorithms.
2. Depict the community discovery in directed networks.

Course Outcome 4 (CO4):

1. Using a neighborhood-based link prediction method compute the top two most likely edges for the following figure.



2. Compute the most likely edge for the following figure for each path based link prediction technique.



Course Outcome 5 (CO5):

1. Discuss different influence based concepts and measures act at local and global levels.
2. What is meant by Existential Test for Social Influence?
3. Explain the Diffusion Influence Model.
4. Explain the different privacy breaches in social networks.

Model Question paper

Course Code: ITT416

Course Name: SOCIAL NETWORK ANALYSIS

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. What are the challenges in social media mining?
2. Explain content based analysis.
3. What is Eigenvector Centrality?
4. Explain Heavy tailed Distributions.
5. Why Text analysis is a part of social network analytics?
6. Discuss the measures for community evaluation.
7. Describe Kernighan-Lin Algorithm.
8. Explain the Simrank Algorithm.
9. Explain influence andhomophily.
10. What are privacy definitions for publishing the data?

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11.	a.	Describe various research issues present Online Social Networks?	4
	b.	Explain the different laws of Dynamic unweighted graphs with suitable diagrams.	10
		OR	
12.	a.	Discuss uses of related patterns in static unweighted graphs.	10
	b.	For a real-world social network, is BFS or DFS more desirable? Provide details.	4
13	a.	Why are random graphs incapable of modeling real-world graphs?	6
	b.	Discuss the relationship between harmonic functions, escape probabilities and commute times.	8
		OR	
14.	a.	Compare and contrast the global and local graph clustering using random walks.	8
	b.	How do you explain Collaborative Filtering and Combating Webspam in	6

connection with random walk?

L

15	a.	Explain Girvan-Newman Algorithm.	6
	b.	What is multi-level Graph partitioning? Explain the main components of MLGP.	8
		OR	
16	a.	Explain why Markov Clusteringis popular in bioinformatics and its major short-comings.	6
	b.	What is meant by community discovery by shingling and how it is different from flow based post processing?	8
		OR	
17	a.	How node neighborhood based features are used in feature set construction?	6
	b.	Discuss the link prediction method using The Katz Score	8
		OR	
18	a.	Explain the purpose of page rank algorithm in detail.	8
	b.	Describe the network evolution based probabilistic model.	6
19	a.	What is homophily? Explain social similarity and Influence in short words.	6
	b.	Explain the roles of different classes; influence and friendship drift and autocorrelation with respect to social influence analysis?	8
		OR	
20	1.	Explain identity and attribute disclosure as part of privacy breeches.	8
	2.	Differentiate between the terms l-diversity and t-closeness.	6

Syllabus

Module 1 : Introduction to Social Network Data Analytics(6 hours)
Introduction to Social Network Analysis , Online social networks Research Issues and Topics, Statistical properties of social networks: Preliminaries, Static properties, Dynamic properties, Challenges of Social Network Streams,
Module 2 :Random Walks in Social Networks(7 hours)
Random walks on Graphics, Walks based on proximity measures, Other graph based proximity measures, Graph theoretic measures for semi supervised learning, Clustering with random walk based measures, Applications in computer vision, Text Analysis, Evaluation and datasets, Link prediction and data sources
Module 3 : Community Discovery in Social Networks(8 hours)
Communities in Context, Core Methods – KL Algorithm, Special algorithms, Markov Clustering, other approaches. Emerging Fields and problems: Community Discovery in dynamic networks, Heterogeneous networks, Directed networks, Coupling content and relationship information for community discovery.
Module 4 : Link Prediction in Social Networks(8 hours)
Background, Feature based Link Prediction, Bayesian Probabilistic Models, Probabilistic Relational Models, Linear Algebraic Methods, Link Predictions: The Katz Score, Hitting & Commute Time, Rooted PageRank, SimRank
Module 5 : Social Influence Analysis(6 hours)
Influence Related Statistics, Social Similarity and Influence, Influence Maximization in Viral Marketing, Privacy breaches in social networks, Privacy definitions for publishing data, Privacy preserving mechanisms.

Text Books

1. Charu.C. Aggarwal, Social Network Data Analytics, Springer Science+Business Media, LLC 2011.

Reference Books

1. R. Zafarani, M. A. Abbasi, and H. Liu, Social Media Mining: An Introduction, Cambridge University Press, 2014.
2. Krishna Raj P M, Ankith Mohan, K G Srinivasa ,Practical Social Network Analysis withPython , Springer Liu, Bing. Web data mining. Springer-Verlag Berlin Heidelberg, 2007.
3. Chakrabarti, Soumen. Mining the Web: Discovering knowledge from hypertext data. Morgan Kaufmann, 2003.
4. Scime, Anthony, ed. Web mining: applications and techniques. IGI Global, 2005.

Course Contents and Lecture Schedule

SlNo.	Topic	No. of Lectures
1	**Introduction to Social Network Data Analytics**	**6 Hour**
1.1	Introduction to Social Network Analysis	1
1.2	Online social networks Research Issues and Topics	1
1.3	Statistical properties of social networks: Preliminaries	1
1.4	Static properties, Dynamic properties	1
1.5	Challenges of Social Network Streams	2
2	**Random Walks in Social Networks**	**7 Hours**
2.1	Random walks on Graphics	1
2.2	Walks based on proximity measures	1
2.3	Other graphs based proximity measures	1
2.4	Graph theoretic measures for semi supervised learning	1
2.5	Clustering with random walk based measures,	1
2.6	Applications in computer vision, Text Analysis,	1
2.7	Evaluation and datasets, Link prediction and Data sources	1
3	**Community Discovery in Social Networks**	**8 Hours**
3.1	Communities in Context	1
3.2	Core Methods – KL Algorithm	1
3.3	Special algorithms, Markov Clustering, other approaches	2
3.4	Emerging Fields and problems: Community Discovery in dynamic networks,	2

3.5	Heterogeneous networks and directed networks	1
3.6	Coupling content and relationship information for community discovery.	1
4	**Link Prediction in Social Networks**	**8 Hours**
4.1	Background, Feature based Link Prediction	1
4.2	Bayesian Probabilistic Models	1
4.3	Probabilistic Relational Models	1
4.4	Linear Algebraic Methods	1
4.5	Link Predictions: The Katz Score	1
4.6	Link Predictions: Hitting & Commute Time,	1
4.7	Link Predictions: Rooted PageRank,	1
4.8	Link Predictions: SimRank	1
5	**Social Influence Analysis**	**6 Hours**
5.1	Influence Related Statistics, Social Similarity and Influence,	2
5.2	Influence Maximization in Viral Marketing	1
5.3	Privacy breaches in social networks	1
5.4	Privacy definitions for publishing data, Privacy preserving mechanisms.	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT426	INTERNET OF THINGS	PEC	2	1	0	3

Preamble: This course covers the fundamentals of IoT and provides skills for IoT based product development including the selection of sensors, protocols, hardware boards, interfacing, and implementation for product building. Real life case studies are introduced in this course.

Prerequisite: ITT305 Data Communication and Networking

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the key techniques and theory behind Internet of Things	Level 2: Understand
CO 2	Distinguish between different IoT Protocols and their applications	Level 2: Understand
CO 3	Apply effectively the various enabling technologies (both hardware and software) for IoT.	Level 3: Apply
CO 4	Describe the integration of Cloud and IoT with data acquisition and analytics	Level 2: Understand
CO 5	Design and build IoT system for any one interesting Use case	Level 3: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	-	-	-	-	-	-	-	-	-	1
CO 2	1	1	2	2	-	-	-	-	-	-	-	1
CO 3	2	1	3	-	3	-	-	-	-	-	-	1
CO 4	1	1	2	2	-	-	-	-	-	-	-	1
CO 5	1	1	2	-	3	-	-	-	2	-	-	1

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	15	15	20
Understand	30	25	65
Apply	5	10	15

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define IoT and explain its characteristics.
2. Which are the functional components of IoT
3. Compare IoT with M2M, CPS, WoT.

Course Outcome 2 (CO2)

1. Explain about the different types of IoT Protocols.
2. Differentiate between Connectivity protocols and Transport protocols with suitable examples

3. Explain about MQTT Protocol and its features

Course Outcome 3(CO3):

1. Differentiate between sensors and actuators
2. Design an IoT application to log the temperature values to a file using Raspberry Pi. Illustrate with sample code
3. Differentiate between Scalar and Vector Sensors

Course Outcome 4 (CO4):

1. With a neat diagram illustrate the NIST model for cloud computing
2. Differentiate between SaaS, PaaS, IaaS
3. Explain any two open source cloud platforms with their features

Course Outcome 5 (CO5):

1. Differentiate between a Smart Environment Vs Smart Device
2. Explain how a doorbell can be converted into an IoT smart device with its smart features and implementation details
3. Describe a connected Vehicle ? Explain its features.

Optional Exercises

1. Integrate a temperature sensor like DHT11 with Raspberry Pi and print the values
2. Integrate Raspberry Pi with an IoT-Cloud Platform like Things Speak and log the temperature values from the sensor to the platform
   (Similar Exercises can be done for other sensors like:- Gas(MQ2), Motion(PIR) etc)

Model Question paper

Course Code: ITT426

Course Name: INTERNET OF THINGS

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Define IoT and explain its characteristics
2. Discuss about IoT device Interoperability
3. Explain the different types of IoT Transport Protocols

4. Differentiate between Connectivity protocols and Transport protocols with suitable examples
5. Explain about Scalar and Vector Sensors
6. Differentiate between sensors and actuators
7. With a neat diagram illustrate the NIST model for cloud computing
8. Differentiate between SaaS and PaaS
9. Differentiate between a Smart Environment Vs Smart Device
10. Explain how healthcare can be made smarter by making use of IoT

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11. Write short note about the following
    a) IoT Device interoperability
    b) IoT user interoperability
    c) IoT Challenges 14

OR

12. Explain the architectural stack in IoT and IoT enabling technologies 14
13. Explain any three IoT Data Protocols and their applications 14

OR

14. What do you mean by connectivity technologies? Explain any three connectivity technologies. 14
15. Design an IoT application to log the temperature values to a file using Raspberry Pi. Illustrate with sample code 14

OR

16. Differentiate between Arduino and Raspberry Pi board, their hardware specifications and features 14
17. Discuss about different cloud platforms and their features(Any 3) 14

OR

18. Explain about the various cloud computing service models and their applications 14
19. Explain a case study where a normal device is converted into an IoT smart device with its smart features and its implementation details 14

OR

20. Differentiate between Smart Environment and Smart Device with suitable examples 14

Syllabus

Module 1 : IoT Introduction (6 Hours)
Introduction to loT - loT definition - Characteristics - Things in loT - loT complete architectural stack – IoT, Functional components-loT enabling technologies - loT challenges -Industrial IoT Vs Consumer IoT, loT levels, Machine-to-Machine (M2M) communications, Cyber-Physical-Systems (CPS), Web-of-Things (WoT), Interoperability in IoT-User Vs device interoperability
Module 2: Protocols for loT (8 Hours)
Protocols for loT -Types of protocols based on functionality, infrastructure protocol IPV4/V6, Identification (URLs), Connectivity protocols-(6LowPAN, RPL), Transport/Communication protocols- WIFI, LiFi, BLE, NFC, Data protocols-(MQTT, CoAP, XMP), A cases study with MQTT/CoAP usage
Module 3: IoT Hardware/Software interfacing (8 Hours)
Sensors and Hardware for loT- Sensors Vs Transducers, Sensor Classes:- Analog/Digital, Scalar/Vector, Sensor types; Actuation-introduction, actuators, types; Python basics, Arduino and Raspberry Pi Boards and their features, IoT Implementation case study with any one of the boards and data acquisition from sensors. Open Source Cloud-IoT Platforms and their Applications: ThingsSpeak, DeviceHive, ThingsBoard
Module 4 : Cloud and Data Analytics in IoT (7 Hours)
Cloud and Data analytics- Cloud computing fundamentals-NIST model, essential characteristics, Service models-(SaaS, PaaS, IaaS), Deployment models-(Public, Private, Hybrid), Cloud-Service management and security, Open Source Cloud IoT platforms and their features-(Microsoft Azure, Amazon EC2), Basics of data handling and analytics-Data Handling, Big data and its characteristics, Data flow Model(Generation, Acquisition, Storage, Analysis),
Module 5: IoT Application case studies (6 Hours)
Case studies with architectural analysis: loT applications -Smart environments Vs Smart devices, Smart Cities and Smart Homes - Smart Water - Smart Agriculture - Smart Energy - Smart Healthcare – Connected Vehicles

Text Books

1. Bahga A, Madisetti V , Internet of Things: A hands-on approach; Vijay Madisetti, First Edition ,2014.
2. Shriram K Vasudevan, Abhishek SN and Sundaram RMD. Internet of Things, Wiley India First Edition,;2019
3. Raj P, Raman AC. The Internet of things: Enabling Technologies, Platforms, and Use-cases. Auerbach Publications; 2017.

References

1. NPTEL Course on Introduction to Internet of Things by IIT Kharagpur
   https://nptel.ac.in/courses/106/105/106105166/
2. Article about Open Source Cloud-IoT Platforms
   https://www.opensourceforu.com/2018/10/the-top-open-source-iot-platforms-for-developers/
3. Links to Some useful Cloud-IoT Platform
   https://thingspeak.com/
   https://devicehive.com/
   https://thingsboard.io

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**IoT Introduction**	**6 Hours**
1.1	Introduction to loT - loT definition - Characteristics - Things in loT - loT Complete Architectural Stack – IoT	2
1.2	Functional Components-loT enabling Technologies - loT Challenges -Industrial IoT Vs Consumer IoT, loT Levels	2
1.3	Machine-to-Machine (M2M) communications, Cyber-Physical-Systems (CPS), Web-of-Things (WoT), Interoperability in IoT-User Vs Device interoperability	2
2	**IoT Protocols**	**8 Hours**
2.1	Protocols for loT -Types of protocols based on functionality, infrastructure protocol IPV4/V6, Identification (URLs),	3
2.2	Connectivity Protocols-(6LowPAN, RPL),	1
2.3	Transport/Communication Protocols- (WIFI, LiFi, BLE, NFC), ,	1
2.4	Data Protocols-(MQTT, CoAP, XMP)	2
2.5	A Case Study with MQTT/CoAP usage	1
3	**IoT Hardware/Software interfacing**	**8 Hours**
3.1	Sensors and Hardware for loT- Sensors Vs Transducers, Sensor Classes:- Analog/Digital, Scalar/Vector, Sensor types	2
3.2	Actuation-introduction, actuators, types; Python Basics	1
3.3	Arduino and Raspberry Pi Boards and their features	2
3.4	IoT Implementation Case study with any one of the boards and data acquisition from sensors.	2
4	**Cloud and Data Analytics in IoT**	**7 Hours**
4.1	Cloud and Data analytics- Cloud computing fundamentals-NIST model, essential characteristics,	1

4.2	Service models-(SaaS, PaaS, IaaS), Deployment models-(Public, Private, Hybrid), Cloud-Service management and security,	2
4.3	Open Source Cloud platforms and their features-(OpenStack, Microsoft Azure, Amazon EC2)	2
4.4	Basics of Data Handling and Analytics-Data Handling, Big data and its characteristics, Data flow Model(Generation, Acquisition, Storage, Analysis),	2
5	**IoT Application case studies**	**6 Hours**
5.1	Case studies with architectural analysis: loT applications -Smart environments Vs Smart devices	2
5.2	Smart Cities and Smart Homes	1
5.3	Smart Water - Smart Agriculture	1
5.4	Smart Energy - Smart Healthcare, Connected Vehicles	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT436	HIGH SPEED NETWORKS	PEC	2	1	0	3

Preamble: This course introduces the basic concept of frame relay and ATM networks, describes the end-to-end performance parameters and techniques used by TCP, updates knowledge about the development in high speed networks and discuss about various protocols for quality support

Prerequisite: ITT305 Data Communication and Networking

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

CO No.	Course Outcome(CO)	Bloom's Category
CO 1	Explain the Asynchronous Transfer Mode Protocol architecture and High Speed Local Area Network Applications.	Level 2: Understand
CO 2	Discuss the Queuing Models, frame relay to manage the traffic and congestion control in High Speed Network.	Level 2: Understand
CO 3	Compare congestion control and traffic management in TCP with Asynchronous Transfer Mode protocol in High Speed Networks	Level 2: Understand
CO 4	Describe the Architecture of Integrated and Differentiated services	Level 2: Understand
CO 5	Outline the protocols for Quality of Service Support	Level 2: Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	1	-	-	-	-	-	-	-	-	-
CO 2	3	2	2	-	-	-	-	-	-	-	-	-
CO 3	2	1	1	-	-	-	-	-	-	-	-	-
CO 4	2	2	2	-	-	-	-	-	-	-	-	-
CO 5	2	1	1	-	-	-	-	-	-	-	-	-

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	40	40	80
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the various ATM service categories in detail.
   What are the requirements for WLAN? Explain the IEEE802.11 architecture in detail.
2. Write short notes on
   a) Wireless LANs.

b) Wi-fi networks.
c) Wi-Max networks.

3. What is Ethernet? Discuss in detail about Fast Ethernet & Gigabit Ethernet.

Course Outcome 2 (CO2)

1. Explain the effects of congestion in packet switching networks.
2. Explain how congestion avoidance is done in frame relay networks.
3. Explain about traffic management in packet switching networks.
4. Describe the single server queuing model with its structures and parameters.

Course Outcome 3(CO3):

1. Describe TCP congestion control
2. Discuss timer management in transmission control protocol
3. Explain with an example guaranteed frame rate(GFR) traffic management in ATM networks
4. Describe the mechanisms used in ATM traffic control to avoid congestion condition

Course Outcome 4 (CO4):

1. Give the requirements for inelastic traffic
2. Explain RED algorithm in detail
3. Discuss about various queuing discipline

Course Outcome 5 (CO5):

1. Discuss about various protocols for quality support

Model Question paper

Course Code: ITT436

Course Name: HIGH SPEED NETWORKS

Max.Marks: 100 **Duration: 3 Hrs**

PART A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Explain the role of frame relay?
2. Write short notes on Fast Ethernet and Gigabit Ethernet?
3. Outline the reasons for congestion in communication network?
4. Explain about single server Queue and its applications

5. Write down various window management techniques
6. State Kendall's notation
7. Write the five DS traffic conditioner elements
8. Describe the design goals for RED
9. Explain the design goals of resource reservation protocol
10. Define MPLS?

PART B

Answer all questions. Each question carries 14 marks. (5*14=70 Marks)

11.	a.	Explain about frame relay networks in detail with suitable diagram	8
	b.	Describe the various requirements specific to wireless LAN	6
		OR	
12.	a.	Explain about Fibre Channel networks	8
	b.	Explain with diagrammatic illustration ATM protocol architecture.	6
13.	a	Explain the effects of congestion and the different congestion control methodologies in packet switching networks	7
	b	Explain in detail about the concept of traffic management	7
		OR	
14.		What are queuing systems? Classify queuing models and discuss the same	14
15.	a.	Write about KARN's algorithm and window management	8
	b.	Compare the performance of TCP over ATM	6
		OR	
16.	a.	Explain in detail about GFR traffic management	10
	b.	Explain in detail about the Jackson's Algorithm	4
17.	a.	Discuss in detail about ISA architecture	7
	b.	With neat diagram write about differentiated services	7
		OR	
18.		Write in detail about queuing discipline: a. BRFQ, b. GPS, c. WFQ	14

d. FQ

19.	a. Describe about RSVP characteristics in detail	7
	b. Discuss in detail about RSVP protocol mechanism	7

OR

20.	a.Write about Real time Transport Protocol (RTP) protocol architecture	8
	b. Describe in detail about RTCP	7

Syllabus

Module 1(7 hours)
Frame Relay Networks , Asynchronous transfer mode , ATM protocol architecture, ATM logical connection , ATM cell , ATM service categories , AAL. High speed LAN's: Fast Ethernet ,Gigabit Ethernet, Fibre channel , Wireless LAN's, WiFi and WiMax networks applications, requirements , Architecture of 802.11.
Module 2(7 hours)
Queuing analysis, Queuing models, Single server queues, Effects of congestion, Congestion control, Traffic management, Congestion control in packet switching networks, Frame relay congestion control.
Module 3(9 hours)
TCP flow control ,TCP congestion control ,Retransmission ,Timer management , Exponential RTO backoff , KARN's algorithm , Window management , Performance of TCP over ATM. Traffic and congestion control in ATM ,Requirements , Attributes , Traffic management frame work, Traffic control , ABR traffic management , ABR rate control, RM cell formats , ABR capacity allocations, GFR traffic management.
Module 4(7 hours)
Integrated Services Architecture ,Approach, Components, Services- Queuing discipline , FQ , PS , BRFQ , GPS , WFQ , Random early detection , Differentiated services.
Module 5(5 hours)
RSVP, Goals &characteristics, Data flow, RSVP operations, Protocol mechanisms, Multiprotocol label switching, Operations, Label stacking, Protocol details, RTP, Protocol architecture, Data transfer protocol, RTCP.

Text Books

1. William Stallings, High speed networks and internet, Pearson Education, Second Edition, 2002.

Reference Books

1. Warland, PravinVaraiya, High performance communication networks, Jean Harcourt Asia Pvt. Ltd., Second Edition , 2001.

2. IrvanPepelnjk, Jim Guichard, Jeff Apcar, MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2003.
3. Abhijit S. Pandya, Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks", CRC Press, New York, 2004
4. https://www.sics.se/~peter/HSN-visions.htm

Course Contents and Lecture Schedule

Module 1: HIGH SPEED NETWORKS		**7 hours**
1.1	Frame Relay Networks , Asynchronous transfer mode	1
1.2	ATM Protocol Architecture,	1
1.3	ATM logical Connection, ATM Cell, ATM Service Categories, AAL.	1
1.4	High Speed LAN's: Fast Ethernet ,Gigabit Ethernet, Fibre Channel	2
1.5	Wireless LAN's, WiFi and WiMax Networks applications, requirements, Architecture of 802.11.	2
Module 2: CONGESTION AND TRAFFIC MANAGEMENT		**7 hours**
2.1	Queuing Analysis , Queuing Models – Single Server Queues	2
2.2	Effects of Congestion , Congestion Control	1
2.3	Traffic Management ,Congestion Control in Packet Switching Networks	2
2.4	Frame Relay Congestion Control.	2
Module 3:TCPAND ATM CONGESTION CONTROL		**9 hours**
3.1	TCP Flow control , TCP Congestion Control	1
3.2	Retransmission , Timer Management	1
3.3	Exponential RTO backoff, KARN's Algorithm	1
3.4	Window management , Performance of TCP over ATM	2
3.5	Traffic and Congestion control in ATM ,Requirements , Attributes ,Traffic Management Frame work	2
3.6	Traffic Control , ABR traffic Management , ABR rate control, RM cell formats , ABR Capacity allocations , GFR traffic management	2
Module 4: INTEGRATED AND DIFFERENTIATED SERVICES		**7 hours**
4.1	Integrated Services Architecture , Approach, Components, Services	2
4.2	Queuing Discipline , FQ , PS	2
4.3	BRFQ , GPS , WFQ , Random Early Detection	2
4.4	Differentiated Services	1
Module 5: PROTOCOLS FOR QOS SUPPORT		**5 hours**
5.1	RSVP – Goals & Characteristics	1
5.2	Data Flow, RSVP operations – Protocol Mechanisms	1
5.3	Multiprotocol Label Switching – Operations, Label Stacking – Protocol details	2
5.4	RTP – Protocol Architecture – Data Transfer Protocol– RTCP.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
ITT446	ADHOC AND WIRELESS SENSOR NETWORKS	PEC	2	1	0	3

Preamble: Students will be able to learn ad hoc network and Sensor network fundamentals, understand the different routing protocols, develop in-depth knowledge on sensor network architecture and design issues, and understand the transport layer and security issues in ad hoc and sensor networks

Prerequisite: ITT305 Data Communication and Networking

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

CO No.	Course Outcomes(CO)	Bloom's Category Level
CO 1	Explain the basics of MAC protocols and routing protocols used in mobile ad hoc networks	Level 2: Understand
CO 2	Discuss the transport layer protocols and achieving QoS in mobile ad hoc networks	Level 2: Understand
CO 3	Describe the basics of MAC protocols and routing protocols used in wireless sensor networks	Level 2: Understand
CO 4	Discuss the transport layer and operating systems used in wireless sensor networks	Level 2: Understand
CO 5	Describe the security issues in wireless sensor networks	Level 2: Understand

Mapping of course outcomes with program outcomes

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	-	-	-	-	-	-	-	-	2
CO 2	3	2	1	-	-	-	-	-	-	-	-	2
CO 3	3	2	1	-	-	-	-	-	-	-	-	2
CO 4	3	2	1	-	-	-	-	-	-	-	-	2
CO 5	3	2	1	-	-	-	-	-	-	-	-	2

3/2/1: high/medium/low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination Marks
	Test 1	Test 2	
Remember	20	20	20
Understand	30	30	80
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the features of contention based routing protocols
2. Compare proactive and reactive routing protocols
3. What are the features of ad hoc networks?

Course Outcome 2 (CO2)

1. Explain about the issues and challenges in providing QoS in mobile ad hoc networks
2. What are the advantages of snooping TCP over I-TCP?
3. Explain in detail about the transport protocols for ad hoc networks

Course Outcome 3(CO3):

1. List the features of ZigBee
2. Why do we need MAC protocols for wireless sensor networks
3. Explain about the hybrid MAC protocols for wireless sensor networks

Course Outcome 4 (CO4):

1. Describe the taxonomy of routing and data dissemination protocols used in wireless sensor networks
2. Discuss the features of sensor protocols for information via negotiation
3. Explain the features of Contiki OS

Course Outcome 5 (CO5):

1. What are the security vulnerabilities in wireless sensor networks?
2. Discuss about the key management protocols used in wireless sensor networks
3. Explain in detail about TESLA

Model Question Paper

Course Code: ITT446

Course Name: ADHOC AND WIRELESS SENSOR NETWORKS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks. (10 * 3 = 30 Marks)

1. Discuss the issues in designing routing protocols for ad hoc networks?
2. What are the advantages of hybrid routing?
3. List the QoS parameters used in networking
4. Can we use the traditional TCP for ad hoc networks? Justify
5. Describe the challenges in designing MAC protocols for wireless sensor networks
6. Differentiate between WSNs and MANETs
7. Explain the major objectives of TinyOS
8. What is the need for data dissemination in wireless sensor networks?
9. Discuss the major constraints of wireless sensor networks?
10. What is denial of service attack?

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11 Discuss the classification of MAC protocols for ad hoc networks and explain about the contention based MAC protocols 14

OR

12 Explain in detail about the reactive routing protocols for ad hoc networks 14

13 Compare the various TCP solutions for adhoc wireless networks 14

OR

14	Explain in detail about the MAC layer and Network layer QoS solutions.	14
15	Explain in detail about IEEE 802.15.4 protocol stack.	14

OR

16	Explain the network architecture of wireless sensor network	14
17	Explain the LEACH routing with the help of neat diagram. Give its advantages and disadvantages.	14

OR

18	Explain in detail about the transport layer protocol for wireless sensor networks	14
19	Write the layer wise attacks in wireless Sensor networks and explain its impact on networks.	14

OR

20	List the possible solutions to mitigate the denial-of-service attacks in sensor networks and explain how it improves the performance of the system.	14

Syllabus

Module 1: MAC & Routing in Ad hoc Networks (7Hours)
Introduction – Issues and challenges in ad hoc networks – MAC Layer Protocols for wireless ad hoc networks – Contention-Based MAC protocols – MAC Protocols Using Directional Antennas – Multiple-Channel MAC Protocols – Power-Aware MAC Protocols – Routing in Ad hoc Networks – Design Issues – Proactive, Reactive and Hybrid Routing Protocols
Module 2: Transport & QoS in Ad hoc Networks(6 Hours)
TCP challenges and Design Issues in Ad Hoc Networks – Transport protocols for ad hoc networks – Issues and Challenges in providing QoS – MAC Layer QoS solutions – Network Layer QoS solutions – QoS Model
Module 3: Wireless Sensor Networks(7Hours)
Introduction to wireless sensor networks (WSN), Network architecture and protocol stack, MAC access control – fundamental MAC protocols, MAC design for WSNs, MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols), IEEE 802.15.4, Zigbee
Module 4: Routing and Transport Layer (8Hours)
Routing and data dissemination – Fundamentals and challenges, taxonomy of routing and data dissemination protocols, Overview of routing and data dissemination protocols – geographic adaptive fidelity, LEACH, Sensor protocols for information via negotiation, joint mobility and routing protocol. Transport Protocols and Quality of Service – Transport protocol design for WSNs, Transport protocols for WSNs, Operating systems for sensor networks – TinyOs, Contiki
Module 5: Security in WSNs (7Hours)
Security requirements in WSNs, Security vulnerabilities in WSNs – DoS attacks, physical layer attacks, link layer, network layer, transport layer attacks, Attacks on secrecy and authentication, Security mechanisms for WSNs – cryptography in WSNs, Key management

protocols, Defence against DoS attacks, Defence against routing attacks - TESLA, SPINS , Intrusion detection in WSNs.

Text Books

1. Jun Zheng, Abbas Jamalipour, Wireless Sensor Networks: A Networking Perspective, John Wiley, 2009
2. C.Siva Ram Murthy and B.S.Manoj, Ad Hoc Wireless Networks – Architectures and 2 Protocols, Pearson Education,1/e, 2006.

References

1. https://arxiv.org/ftp/arxiv/papers/1301/1301.5065.pdf
2. Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2005

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**MAC & Routing in Ad hoc Networks**	**7 Hours**
1.1	Introduction – Issues and challenges in ad hoc networks	1
1.2	MAC Layer Protocols for wireless ad hoc networks	1
1.3	Contention-Based MAC protocols	1
1.4	MAC Protocols Using Directional Antennas – Multiple-Channel MAC Protocols – Power-Aware MAC Protocols	1
1.5	Routing in Ad hoc Networks – Design Issues	1
1.6	Proactive and Reactive Routing Protocols	1
1.7	Hybrid Routing Protocols	1
2	**Transport & QoS in Ad hoc Networks**	**6 Hours**
2.1	TCP challenges and Design Issues in Ad Hoc Networks	1
2.2	Transport protocols for ad hoc networks	2
2.3	Issues and Challenges in providing QoS	1
2.4	MAC Layer QoS solutions	1
2.5	Network Layer QoS solutions – QoS Model	1
3	**Wireless Sensor Networks**	**7 Hours**
3.1	Introduction to wireless sensor networks (WSN)	1
3.2	Network architecture and protocol stack	1
3.3	MAC access control – fundamental MAC protocols, MAC design for WSNs	1
3.4	MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols)	1
3.5	MAC protocols for WSN (Hybrid protocols)	1
3.6	IEEE 802.15.4	1
3.7	Zigbee	1
4	**Routing and Transport Layer**	**8 Hours**

4.1	Routing and data dissemination – Fundamentals and challenges, taxonomy of routing and data dissemination protocols	1
4.2	Overview of routing and data dissemination prot INFORMATION ocols	
4.3	Geographic adaptive fidelity, LEACH	1
4.4	Sensor protocols for information via negotiation, joint mobility and routing protocol, GPSR.	1
4.5	Transport Protocols and Quality of Service	1
4.6	Transport protocol design for WSNs	1
4.7	Transport protocols for WSNs	1
4.8	Operating systems for sensor networks – TinyOs, Contiki	1
5	**Security in WSNs**	**7 Hours**
5.1	Security requirements in WSNs	1
5.2	Security vulnerabilities in WSNs – DoS attacks, physical layer attacks, link layer	1
5.3	Network layer, transport layer attacks, Attacks on secrecy and authentication	1
5.4	Security mechanisms for WSNs,	1
5.5	Cryptography in WSNs	1
5.6	Key management protocols, Defence against DoS attacks	1
5.7	Defence against routing attacks - TESLA, SPINS , Intrusion detection in WSNs.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT456	HUMAN COMPUTER INTERFACING	PEC	2	1	0	3

Preamble: The goal of this course is for the students, working in teams, to propose a new human computer interface, or an improvement to an existing interface, to solve a particular problem. The course is split into five modules: Human Computer Interface Foundation, Designing Interaction, Interaction Design Models, Guidelines in HCI and Collaboration, Human Factors, Security and Validation Concepts.

Prerequisite: Nil

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

CO No.	Course Outcome (CO)	Bloom's Category
CO 1	Describe the basic concepts of human, computer interactions	Level 1: Understand
CO 2	Depict the processes of human computer interaction life cycle	Level 2: Understand
CO 3	Discuss the various interaction design models	Level 2: Understand
CO 4	Learn design standards/guidelines for evaluating the developed interactions	Level 2: Understand
CO 5	Describe the principles of human computer interactions through the prototype mode and validations	Level 2: Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	1	-	-	1	-	-	-	-	-	1
CO 2	2	2	1	-	-	1	-	-	-	-	-	1
CO 3	2	2	2	1	-	-	-	-	-	-	-	2
CO 4	2	2	2	1	-	1	-	-	-	-	-	1
CO 5	2	2	1	1	-	1	-	-	-	-	-	2

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	40	40	80
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the relation between psychology and the design of interactive systems.
2. Differentiate between text entry devices and display devices.
3. Explain about virtual reality and 3D interaction devices.

Course Outcome 2 (CO2):

1. Illustrate the known interactive design models.

2. Explain about the framework used for discovery.

3. Explain what is meant by Iteration and prototyping?

Course Outcome 3 (CO3):

1. Explain Task hierarchy of cognitive models.
2. What are Linguistic models?
3. What are applications of physical models?
4. Explain GOMS Analysis.
5. Explain the working of communication and collaborative models.
6. What is meant face to face communication?
7. Describe group working.
8. What are the outcomes of task decompositions?

Course Outcome 4 (CO4):

1. List the Shneiderman's eight golden rules.
2. What are Norman's Seven Principles for transforming difficult tasks into simple ones?
3. Why are there few effective HCI standards?
4. What is Nielsen's heuristics and heuristic evaluation technique?

Course Outcome 5 (CO5):

1. What decision support systems?
2. Identify the frameworks for groupware.
3. What is cognitive walk-through?
4. Explain the applications of augmented and Virtual reality.
5. How do you implement synchronous groupware?

Model Question paper

Course Code: ITT456
Course Name: HUMAN COMPUTER INTERFACING

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. What are the underlying principles of HCI?
2. Explain about human memory, reasoning and problem solving.
3. Explain positioning and pointing devices.
4. Differentiate between elicitation and interpretation.
5. Explain the challenges involved in display-based systems.
6. Explain the operation of key stroke level model.
7. Explain the GOMS Analysis in detail.
8. State and explain the Norman's principles.
9. Summarize the principles affecting learnability.
10. Compare and contrast usability testing and interface testing.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11. a. Explain the various devices used for virtual reality and 3D interaction in detail. 10

    b. What is meant by emotion and individual differences? 4

OR

12. a. Explain in detail about psychology and design of interactive systems. 10

    b. What are sensors and special devices? Write short answer. 4

13. a. Explain the discovery framework? 6

	b.	Explain the Screen design and Layout in detail.	8
		OR	
14.	a.	What are the phases of task analysis?	6
	b.	Explain the task decomposition procedure in detail.	8
15.	a.	Compare and contrast three state model and keystroke model.	10
	b.	Explain how encoding is done in keyboard level model.	4
		OR	
16.	a.	Write short notes on principles to support usability.	6
	b.	Explain the Keyboard level model and the heuristic for operator placement.	8
17.	a.	Explain Norman's model of interaction in detail.	6
	b.	Explain Nielsen's ten heuristics.	8
		OR	
18.	a.	Explain Shneiderman's eight golden rules in detail	10
	b.	What is Contextual evaluation?	4
19.	a.	What are shared artifacts? Explain.	6
	b.	Explain the meeting and decision support systems.	8
		OR	
20.	a.	What do you mean by perceptual interfaces?	4
	b.	Illustrate the Augmented and virtual reality validations.	10

Syllabus

Module 1: HCI Foundations (7 hours)
Input–output channels, Human memory- Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices – Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction - Physical controls, sensors and special devices.
Module 2 : Designing Interaction (6 hours)
Models of Interaction, Frameworks and HCI, Interaction Styles, Contexts of Interaction, The Process of Design, Navigation Design, Screen Design and Layout, Iteration and Prototyping.
Module 3: Cognitive Models (9 hours)
Goal and Task hierarchy, GOMS, Linguistic Models, Physical and device Models, Cognitive architectures, Communication and collaboration models, Face to face communication, Text Based communication, Group working, Task Analysis, Task decomposition.
Module 4: Design Rules, Guidelines in HCI and Evaluation (6 hours)
Principles to support usability, standards and guidelines, Shneideman's eight golden rules, Nielsen's ten heuristics, Heuristic evaluation, contextual evaluation, Evaluation through expert analysis, evaluation through user participation
Module 5: Human Factors And Security and Validation Concepts (7 hours)
Groupware systems, computer mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware Implementing synchronous groupware, Augmented and Virtual Reality, Validations - Usability testing, Interface Testing, User Acceptance Testing

Textbooks

1. A Dix, Janet Finlay, G D Abowd, R Beale., Human-Computer Interaction, 3rd Edition, Pearson Publishers,2008
2. Shneiderman, Plaisant, Cohen and Jacobs, Designing the User Interface: Strategies for Effective Human Computer Interaction, 5th Edition, Pearson Publishers, 2010.

Reference Books

1. Rogers, Sharp & Preece, Interaction Design, Beyond Human-Computer Interaction, Third Edition, Wiley, 2014.
2. Pamayiotis Zaphiris & Sri Kurniawan, Human Computer Interaction research in Web Design and Evaluation, First Edition, Idea Group Publishing, 2007.

3. Dan, R. Olsen, Jy, Human Computer Interaction, First Edition, Cengage Learning, 2010.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**HCI Foundations**	**7 hours**
1.1	Input–Output channels	1
1.2	Human memory	2
1.3	Individual differences	1
1.4	Text entry devices	1
1.5	Display devices	1
1.6	Devices for virtual reality and 3D interaction	1
2	**Designing Interaction**	**6 hours**
2.1	Models of Interaction, Frameworks and HCI	1
2.2	Interaction Styles	1
2.3	Contexts of Interaction	1
2.4	The Process of Design, Navigation Design	1
2.5	Screen Design and Layout	1
2.6	Iteration and Prototyping	1
3	**Cognitive Models**	**9 hours**
3.1	Goal and Task hierarchy	1
3.2	GOMS, Linguistic Models	1
3.3	Physical and device Models	1
3.4	Cognitive architectures	1
3.5	Communication and collaboration models	1
3.6	Face to face communication, Text Based communication	1
3.7	Group working	1
3.8	Task Analysis, Task decomposition.	2
4	**Design Rules, Guide Lines in HCI and Evaluation**	**6 hours**
4.1	Principles to support usability, standards, and guidelines	1
4.2	Shneideman's eight golden rules	1
4.3	Nielsen's ten heuristics, Heuristic evaluation	1
4.4	contextual evaluation,	1
4.5	Evaluation through expert analysis,	1
4.6	Evaluation through user participation	1
5	**Human Factors, Security and Validation Concepts**	**7 hours**
5.1	Groupware systems, computer mediated communication,	2
5.2	Meeting and decision support systems, Shared applications and artifacts	1
5.3	Frameworks for groupware, Implementing synchronous Groupware	2

5.4	Augmented and Virtual Reality	1
5.5	Usability testing, Interface Testing, User Acceptance Testing perceptual interfaces	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT466	PARALLEL PROCESSING	PEC	2	1	0	3

Preamble: The main goal of this course is to equip students with knowledge and skills on how parallel architecture and how parallel algorithms could run on modern computing devices

Prerequisite: ITT204 Computer Organization

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Explain the basic concepts of parallel processing and parallel processors.	Level 2: Understand
CO 2	Outline the management of parallel systems shared memory and interconnection networks	Level 2: Understand
CO 3	Discuss the significance of Core Level Parallel Processing, Grid and Cloud Computing	Level 2: Understand
CO 4	Describe the significance of Parallel Algorithms	Level 2: Understand
CO 5	Write and demonstrate simple Parallel Programs	Level 3: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	1	-	-	-	-	-	-	-	2
CO 2	3	2	2	1	-	-	-	-	-	-	-	2
CO 3	3	2	2	1	-	-	-	-	-	-	-	2
CO 4	3	2	3	1	-	-	-	-	-	-	-	2
CO 5	3	2	3	2	2	-	-	-	-	-	-	2

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	20	10	20
Level 2: Understand	30	30	70
Level 3: Apply		10	10
Level 4: Analyze			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have a maximum 2 subdivisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Discuss Pipelining.
2. Explain the features of superscalar processors.
3. List the advantages of Multithreaded Processors?

Course Outcome 2 (CO 2):

1. What are SIMD Computers?
2. How Message Passing takes place in Parallel Computers?
3. List the applications of an Array Processor?

Course Outcome 3 (CO 3):

1. Discuss the generalized structure of Chip Multiprocessors(CMPs).
2. List the issues which arise while designing the interconnection system between cores in a multicore processor.
3. Explain the features of General Purpose Graphics Processing Unit (GPGPU)

Course Outcome 4 (CO 4):

1. Explain the structure of RAM
2. List the four categories of PRAM Model
3. Discuss the procedure for mesh search.

Course Outcome 5 (CO 5):

1. Write an OpenMP program to compute π
2. What are CUDA Threads, Thread Blocks, Grid and Kernel
3. Write a CUDA program to multiply two matrices.

Model Question Paper

Course Code: ITT466
Course Name: PARALLEL PROCESSING

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. What is the difference between Branch Prediction Buffer and Branch Target Buffer used to reduce the delay in control dependency?
2. What are VLIW processors?
3. List the advantages of shared memory parallel computers using a bus for sharing memory and an interconnection network for sharing memory.
4. What is the difference between a blocking switch and a non-blocking switch?
5. The number of transistors which are packed in a microprocessor chip has been doubling every two years. Will this trend stop? Explain the reasoning for your answer.
6. What are the differences between a chip multiprocessor and a many core processor?
7. Differentiate between RAM and PRAM
8. How do we perform searching on tree interconnection networks?
9. What are the advantages and disadvantages of explicit and implicit parallel programming approaches?
10. Write short notes on the real world applications of Hadoop.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11	a.	Compare Data and Temporal parallel processing	5
	b.	Explain in detail about Multithreaded Processors	9

OR

12	a.	Discuss the delays in pipelining	9
	b.	Explain Instruction level Parallelism	5
13	a.	What are the similarities and differences between (i) Vector processing, (ii) Array processing, and (iii) Systolic processing? Give an application of each of these modes of computation in which their unique characteristics are essential.	9
	b.	Write short notes on Distributed Shared Memory Parallel Computers	5

OR

14	a.	Discuss Flynn's Classification of Computers	7
	b.	Explain Routing techniques for Directly Connected Multicomputer Systems	7
15	a.	Explain the structure of Chip Multiprocessor with neat diagram	10
	b.	Enumerate the differences between multithreaded parallelism and multicore parallelism.	4

OR

16	a.	Write short notes on cache coherence protocols used in CMPs	4
	b.	What are the types of interconnection networks used to interconnect cores in many-core processors? List the advantages and disadvantages of each of these.	10
17	a.	Discuss Concurrent Read Concurrent Write (CRCW) PRAM	4
	b.	Explain the various parallel algorithms to perform matrix multiplication	10

OR

18	a.	Write short notes on the analysis of parallel algorithms	4
	b.	Discuss how searching is done in a sorted sequence and a random sequence in PRAM Models	10
19	a.	What are the OpenMP synchronization constructs ?	4
	b.	Write CUDA and OpenCL programs to transpose a square matrix.	10

OR

20	a	Discuss message passing with MPI	4
	b.	Write a pseudocode that illustrates the basic structure of a MapReduce program that counts the number of occurrences of each word in a collection of documents.	10

Syllabus

Module 1: Introduction (7 Hours)
Introduction, Solving Problems in Parallel, Instruction Level Parallel Processing, Pipelining of Processing Elements, Delays in Pipeline Execution ,Difficulties In Pipelining , Superscalar Processors , Very Long Instruction Word (VLIW) Processor, Some commercial processors Multithreaded Processors.
Module 2: Parallel Computers, Shared Memory Concepts & Interconnection Networks (7 Hours)
Structure of Parallel Computers, A Generalized Structure of a Parallel Computer; Classification of Parallel Computers , Vector Computers , A Typical Vector Supercomputer, Array Processors, Systolic Array Processors, Shared Memory Parallel Computers, Interconnection Networks, Distributed Shared Memory Parallel Computers, Message Passing Parallel Computers
Module 3: Core Level Parallel Processing (7 Hours)
Core Level Parallel Processing: Consequences of Moore's law and the advent of chip multiprocessors , A generalized structure of Chip Multiprocessors ,MultiCore Processors or Chip MultiProcessors (CMPs), Chip Multiprocessors using Interconnection Networks , General Purpose Graphics Processing Unit (GPGPU)
Module 4: Parallel Algorithms (7 Hours)
Parallel Algorithms , Models of Computation - RAM - PRAM ,Analysis of Parallel Algorithms Searching,Matrix Operations -Matrix Multiplication
Module 5: **Parallel Programming(7 Hours)**
Parallel Programming , Message Passing Programming with MPI , Shared Memory Programming with OpenMP , Heterogeneous Programming with CUDA and OpenCL , Programming in Big Data Era -Mapreduce -Hadoop

Text Books

1. V Rajaraman, C Siva Ram Murthy, Parallel Computers- Architecture and Programming, PHI learning, Second edition, 2016.

Reference Books

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, Introduction to Parallel Computing, Addison-Wesley an imprint of Pearson Education, Second Edition, 2003. (http://wwwusers.cs.umn.edu/~karypis/parbook/).

2. Vipin Kumar, Ananth Grama, Anshul Gupta, and George Karypis, Introduction to Parallel Computing Design and Analysis of Algorithms, The Benjamin/Cummings Publishing Company, Inc. 1994.

3. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP, Mc Graw Hill, 2003.

4. Harry F. Jordan and Gita Alaghband, Fundamentals of Parallel Processing, Prentice Hall and Pearson Education, 2003.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Introduction**	**7 Hours**
1.1	Why Do We Need High Speed Computing? - How Do We Increase The Speed Of Computers? Some Interesting Features Of Parallel Computers	1
1.2	Utilizing Data Parallelism -Comparison of Temporal And Data Parallel Processing	1
1.3	Data Parallel Processing With Specialized Processors-Inter-Task Dependency Instruction Level Parallel Processing	1
1.4	Instruction Level Parallel Processing; Pipelining of Processing Elements ; Delays In Pipeline Execution	1
1.5	Difficulties in Pipelining; Superscalar Processors; Very Long Instruction Word (VLIW) Processor	1
1.6	Some Commercial Processors : ARM Cortex A9 Architecture, Intel Core I7 Processor , IA-64 Processor Architecture	1
1.7	Multithreaded Processors - Coarse Grained Multithreading, Fine Grained Multithreading , Simultaneous Multithreading	1
2	**Parallel Computers, Shared Memory Concepts & Interconnection Networks**	**7 Hours**
2.1	A Generalized Structure of a Parallel Computer -Classification of Parallel Computers - Flynn's Classification	1
2.2	Coupling Between Processing Elements, Classification Based On Mode of Accessing Memory , Classification Based On Grain Size	1
2.3	Vector Computers- A Typical Vector Supercomputer- Array Processors - Systolic Array Processors	1
2.4	Shared Memory Parallel Computers Synchronization of Processes in Shared Memory Computers	1
2.5	Shared Bus Architecture - Shared Memory Parallel Computer using an Interconnection Network.	1
2.6	Interconnection Networks - Networks to Interconnect Processors to Memory or Computers to Computers	1
2.7	Direct Interconnection of Computers - Routing Techniques For Directly Connected Multicomputer Systems, Distributed Shared Memory Parallel Computers	1
3	**Core Level Parallel Processing,**	**7 Hours**
3.1	Core Level Parallel Processing: Consequences of Moore's law and the advent of chip multiprocessors	1
3.2	A generalized structure of Chip Multiprocessors	1
3.3	MultiCore Processors or Chip MultiProcessors (CMPs)- -Cache Coherence in Chip Multiprocessors	1
3.4	Chip Multiprocessors using Interconnection Networks - Ring	1

	Interconnection of Processors	
3.5	Ring Bus Connected Chip Multiprocessors - Intel Xeon Phi Coprocessor Architecture [2012]	1
3.6	Mesh Connected Many Core Processors - Intel Teraflop Chip [Peh, Keckler and Vangal, 2009] -	1
3.7	General Purpose Graphics Processing Unit (GPGPU)	1
4	**Parallel Algorithms**	**7 Hours**
4.1	Parallel Algorithms- Models of Computation	1
4.2	The Random Access Machine (RAM)	1
4.3	The Parallel Random Access Machine (PRAM) - Interconnection Networks	1
4.4	Analysis of Parallel Algorithms - Running Time - Number of Processors - Cost	1
4.5	Searching- Searching on PRAM Models	1
4.6	Searching on Interconnection Networks	1
4.7	Matrix Operations- Matrix multiplication only	1
5	**Parallel Programming**	**7 Hours**
5.1	Message Passing Programming - Introduction	1
5.2	Message Passing Programming with MPI	1
5.3	Shared Memory Programming with OpenMP	1
5.4	Shared Memory Programming with OpenCL	1
5.5	Heterogeneous Programming With CUDA	1
5.6	Programming In Big Data Era ,Mapreduce	1
5.7	Programming In Big Data Era , Hadoop	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT476	NETWORK SCIENCE	PEC	2	1	0	3

Preamble: The course seeks to introduce fundamental elements of the emerging science of complex networks and their applications. Network science is an emerging discipline that investigates the topology, structural properties, evolution dynamics, and vulnerabilities of complex networks. The applications of network science span a wide variety of areas: Internet, physical, biological, ecology, and social systems. Network Science course will focus on the algorithmic, computational, and statistical methods of network science. This course will also discuss the robustness of networks, community structures and modelling of the spreading of disease using complex networks.

Prerequisite: MAT 101 Linear Algebra and Calculus, MAT 208 Probability, Statistics and Advanced Graph Theory.

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

CONo.	Course Outcomes (CO)	Bloom's Category Level
CO 1	Discuss the main concepts and characteristics of network science.	Level2: Understand
CO 2	Explain the evolution of random network based on graph theoretical concepts.	Level 2: Understand
CO 3	Interpret the nature of scale free networks based on Barabasi-Albert model.	Level2: Understand
CO 4	Build robust network by assessing the structural vulnerabilities.	Level3: Apply
CO 5	Model disease spreading pattern in communities.	Level 3: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	-	-	1	-	-	-	-	-	-	2
CO 2	3	2	-	-	-	-	-	-	-	-	-	2
CO 3	3	2	-	-	-	-	-	-	-	-	-	2
CO 4	3	3	3	3	3	2	-	-	-	-	-	2
CO 5	3	3	3	3	3	3	-	-	-	-	-	2

3/2/1: high/medium/low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Marks)	Test 2 (Marks)	
Remember	**20**	**5**	**25**
Understand	**30**	**20**	**50**
Apply		**25**	**25**
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the possibilities of understanding the complexity from the perspective of Complex Network.
2. Explain the nature of complex system with an example.
3. Comment on the structural similarity of real-world networks by citing examples.

Course Outcome 2 (CO2)

1. Compare and contrast random networks and real-world networks.

2. Explain the evolution of random network and the emergence of giant component.

3. Explain the use of degree distribution in explaining the structural similarity in networks.

Course Outcome 3(CO3):

1. Explain the Scale Free phenomenon and its significance.

2. Compare real network and random network based on average path length, clustering coefficient and degree distribution.

3. Explain the presence of hubs in real networks based on Barabasi-Albert model.

Course Outcome 4 (CO4):

1. Consider a star network, where a single node is connected to N – 1 degree one nodes. Assume that $N \gg 1$.How can you explain the assortative or disassortative nature of this network.
2. Calculate the critical threshold fc for networks with Power law with exponential cut off.
3. Explain the breakdown of a network as inverse percolation.

Course Outcome 5 (CO5):

1. Consider a one-dimensional lattice with N nodes that form a circle, where each node connects to its two neighbours. Partition the line into $n_c$consecutive clusters of size $N_c=N/n_c$. Calculate the modularity of the obtained partition.
2. Calculate the characteristic time τ and the epidemic threshold $\lambda_c$of the SI, SIS and SIR models for networks with Exponential degree distribution.
3. "Random immunization is unable to eradicate a disease, but selective immunization, that targets the hubs can help us eradicate the disease", Do you agree with the statement? Justify your answer.

Model Question paper

Course Code: ITT476
Course Name: NETWORK SCIENCE

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Define complex network. How study of complex network is useful in understanding

the complex systems.

2. Explain the nature of complex system with an example.

3. Define Erdos-Renyi network.

4. Explain the small world phenomenon.

5. Comment on the difference observed in degree distribution of random graphs and scale free networks.

6. Explain clustering coefficient.

7. Define assortative and disassortative network with example.

8. ExplainMolloy-Reed Criterion.

9. Define strong and weak communities.

10. Explain Susceptible-Infected-Recovered (SIR) Model.

PART B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11. Explain the universality of network characteristics by analysing various real world networks. 14

OR

12. Explain the characteristics of network science with example. 14

13.a. Explain the evolution of random network and the emergence of giant component. 7

b. Define Degree distribution? Explain its importance in analysing the structure of Internet. 7

OR

14.a. Compare real network and random network based on average path length, clustering coefficient and degree distribution. 8

b. Compare the structure of random network and real network based on cluster size distribution. 6

15.a. Explain briefly the Scale Free phenomenon and its significance. 8

b. Explain power law distribution. 6

OR

16.a.	Analyse the relationship between the formation of hubs in network and power law degree distribution.	8
b.	Explain Barabasi-Albert model of growth of complex network.	6
17.a.	How can you measure Degree Correlations? Explain how this measure helps to study assortative and disassortative Network.	7
b.	" Scale free network show robustness towards random node failure", Do you agree with the statement, Justify your answer.	7

OR

18.a.	Write a note on percolation theory. Explain How percolation theory is used for studying robustness of a network.	8
b.	Write a note on friendship paradox in the context of scale free networks.	6
19.a.	Suggest and explain one method to find number of ways the nodes of a network can be grouped into communities.	6
b.	Compare and contrast the SI, SIS and SIR Models for Epidemic Modelling.	8

OR

20. a.	Explain agglomerative and divisive procedures used for community detection. Compare them based on computational complexity.	9
b.	Explain how the speed with which a pathogen spreads depends on the degree distribution of the relevant contact network.	5

Syllabus

Module 1: Introduction to Network science (5 Hours)
Introduction to network science- The main premise of network science,History and relation to graph theory, physics, sociology, and other disciplines,Examples of networks from different application domains, The characteristics of Network Science, societal and scientific impact. **Familiarisation of Network analysis and visualization tools**-NetworkX, Gephi, Cytoscape, Infomap, Igraph, Statnet, Network Workbench, Pajek network visualization, Jung network analysis, GraphViz, Matlab's Random Boolean Networks (RBN) toolbox.

Module 2:Random Networks(6 Hours)

Relevant Concepts From Graph Theory-Undirected, directed, signed, weighted and spatial networks, Paths, connected components ,Directed Acyclic Graphs, Bipartite graphs Max-flow/min-cut, Clustering coefficients.

The Random Network Model- Introduction, Number of Links, Degree Distribution in random network, The Evolution of a Random Network, Small Worlds, Clustering Coefficient in random network, Watts-Strogatz model.

Module 3: Scale Free Propertyand The Barabasi-Albert model (7 Hours)

Power Laws and Scale-Free Networks, Discrete Formalism, Continuum Formalism, Hubs, The Meaning of Scale-Free, Universality, Ultra-Small Property, The Role of the Degree Exponent.

The Barabasi-Albert model-Growth and Preferential Attachment, The Barabási-Albert Model, Degree Dynamics, Degree Distribution in BA Model, Measuring Preferential Attachment, Non-linear Preferential Attachment, The Origins of Preferential Attachment, Diameter and Clustering Coefficient.

Module 4: Degree correlations and Network Robustness(8 Hours)

Degree correlations-Assortativity and Disassortativity, Measuring Degree Correlations, Structural Cutoffs, Correlations in Real Networks, Generating Correlated Networks, The Impact of Degree Correlations.

Network Robustness- Percolation Theory, Inverse Percolation Transition and Robustness, Robustness of Scale-free Networks, Molloy-Reed Criterion, Critical Threshold, Attack Tolerance, Cascading Failures, Modelling Cascading Failures, Failure Propagation Model, Branching Model, Building Robustness, Designing Robust Networks.

Module 5: Communities and Spreading Phenomena (9 Hours)

Communities- Basics of Communities, Hierarchical Clustering, Agglomerative Procedures: theRavasz Algorithm, Divisive Procedures: the Girvan-Newman Algorithm, Hierarchy in Real Networks, Modularity, Overlapping Communities, Testing Communities, Characterizing Communities.

Spreading Phenomena- Epidemic Modelling, Susceptible-Infected (SI) Model, Susceptible-Infected-Susceptible (SIS) Model, Susceptible-Infected-Recovered (SIR) Model, Network Epidemics, Susceptible-Infected (SI) Model on a Network, SIS Model and the Vanishing Epidemic Threshold, Contact Networks, Digital Viruses,Beyond the Degree Distribution, Temporal Networks,Bursty Contact Patterns, Complex Contagion, Immunization, Random Immunization, Vaccination Strategies in Scale-Free Networks, Epidemic Prediction, 'What if' Analysis, Effective Distance.

Text Books

1. A-L. Barabási, Network Science, Cambridge University Press 2016, Available online:http://barabasi.com/networksciencebook/
2. M.E.J. Newman, Networks - An introduction , Oxford Univ Press, 2010.
3. D. Easley and J. Kleinberg, Networks, Crowds and Markets , Cambridge Univ Press.

Reference Books

1. R. Cohen and S. Havlin, Complex Networks - Structure, Robustness and Function, Cambridge Univ Press, 2010.
2. M.O. Jackson, Social and Economic Networks, Princeton Univ Press, 2008.
3. Barrat, M. Barthelemy and A. Vespignani, Dynamical Processes on Complex Networks, Cambridge Univ Press, 2008.
4. E. Kolaczyk, Statistical analysis of network data, Springer, 2009.
5. S. Wasserman, K. Faust, Social Network Analysis: Methods and Applications, Cambridge Univ Press, 1994.
6. P. Van Mieghem, Graph Spectra for Complex Networks, Cambridge Univ Press, 2011.
7. R. Diestel, Graph Theory (4th edition), Springer, 2010.
8. R.K.Ahuja and T.L.Magnanti, Network Flows: Theory, Algorithms, and Application, Pearson, 1993.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to network science**	**5 Hours**
1.1	The main premise of network science, History and relation to graph theory, physics, sociology, and other disciplines, Examples of networks from different application domains.	2
1.2	The characteristics of Network Science, societal and scientific impact.	1
1.3	Familiarisation of Network analysis and visualization tools- NetworkX, Gephi, Cytoscape, Infomap, Igraph, Statnet, Network Workbench, Pajek network visualization, Jung network analysis, GraphViz, Matlab's Random Boolean Networks (RBN) toolbox.	2
2	**Random Networks**	**6 Hours**
2.1	Relevant Concepts From Graph Theory -Undirected, directed, signed, weighted and spatial networks ,Paths, connected components.	1
2,2	Directed Acyclic Graphs, Bipartite graphs Max-flow/min-cut, Clustering coefficients.	1
2.3	The Random Network Model- Introduction, Number of Links, Degree Distribution in random network.	1

2.4	The Evolution of a Random Network.	1
2.5	Small Worlds, Clustering Coefficient in random network	
2.6	Watts-Strogatz model.	1
3	**Scale Free Property and The Barabasi-Albert model**	**7 Hours**
3.1	Scale Free Property- Introduction, Power Laws and Scale-Free Networks, Discrete Formalism, Continuum Formalism, Hubs.	2
3.2	The Meaning of Scale-Free, Universality	1
3.3	Ultra-Small Property, The Role of the Degree Exponent.	1
3.4	Growth and Preferential Attachment, The Barabási-Albert Model, Degree Dynamics, Degree Distribution in BA Model, Measuring Preferential Attachment, Non-linear Preferential Attachment.	2
3.5	The Origins of Preferential Attachment, Diameter and Clustering Coefficient.	1
4	**Degree correlations and Network Robustness**	**8 Hours**
4.1	Degree correlations-Introduction**,** Assortativity and Disassortativity, Measuring Degree Correlations.	2
4.2	Structural Cut-offs, Correlations in Real Networks	1
4.3	Generating Correlated Networks, The Impact of Degree Correlations.	1
4.4	Network Robustness- Introduction, Percolation Theory, Inverse Percolation Transition and Robustness, Robustness of Scale-free Networks.	1
4.5	Molloy-Reed Criterion, Critical Threshold, Attack Tolerance.	1
4.6	Modelling Cascading Failures, Failure Propagation Model, Branching Model, Building Robustness, Designing Robust Networks.	2
5	**Communities and Spreading Phenomena**	**9 Hours**
5.1	**Communities-** Introduction, Basics of Communities, Hierarchical Clustering, Agglomerative Procedures: the Ravasz Algorithm, Divisive Procedures: the Girvan-Newman Algorithm.	2
5.2	Hierarchy in Real Networks, Modularity, Overlapping Communities.	1
5.3	Testing Communities, Characterizing Communities.	1
5.4	Spreading Phenomena- Introduction, Epidemic Modelling, Susceptible-Infected (SI) Model, Susceptible-Infected-Susceptible (SIS) Model, Susceptible-Infected-Recovered	2
5.5	Model, Network Epidemics, Susceptible-Infected (SI) Model on a Network, SIS Model and the Vanishing Epidemic Threshold, Contact Networks.	1

5.6	Digital Viruses, Beyond the Degree Distribution, Temporal Networks, Bursty Contact Patterns, Complex Contagion	1
5.7	Immunization, Random Immunization, Vaccination Strategies in Scale-Free Networks, Epidemic Prediction, 'What if' Analysis, Effective Distance.	1

SEMESTER VIII

PROGRAM ELECTIVE V

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT418	INFORMATION STORAGE MANAGEMENT	PEC	2	1	0	3

Preamble: Information Storage Management is a graduate – level preliminary course to understand data creation, the amount of data being created, the value of data to a business, challenges in data storage and data management. The course is divided into five modules: (1) Data, Information (2) DAS, SCSI, SAN (3) NAS (4) Information availability (5) Securing the storage infrastructure

Prerequisite: Nil

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Explain data creation and the value of data to a business.	Level 2: Understand
CO 2	Describe the solutions available for data storage and core elements of a storage infrastructure	Level 2: Understand
CO 3	Summarise concepts of SAN storage technologies	Level 2: Understand
CO 4	Explain concepts of NAS storage technologies	Level 2: Understand
CO 5	Describe challenges in data storage security	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	1	-	-	-	-	-	-	-	-	-
CO 2	3	3	2	-	-	-	-	-	-	-	-	-
CO 3	2	2	1	-	-	-	-	-	-	-	-	-
CO 4	2	2	1	-	-	-	-	-	-	-	-	-
CO 5	2	2	2	-	-	-	-	-	-	-	-	-

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	10	10	20
Level 2: Understand	40	40	80
Level 3: Apply			
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Define Data and Information
2. Explain the evolution of storage architecture and data centre infrastructure
3. Explain Information lifecycle.
4. Describe RAID and Intelligent storage system

Course Outcome 2 (CO 2):

1. Differentiate DAS, SAN and SCSI.
2. Explain various connectivity options.
3. Explain SAN based virtualization.

Course Outcome 3 (CO 3):

1. Describe NAS, its benefits, components, implementations.
2. Explain object based storage.
3. Describe CAS

Course Outcome 4 (CO 4):

1. Explain information availability
2. Describe backup and restore and SCB - Topologies
3. Explain local replication, remote replication and advanced replication technologies.

Course Outcome 5 (CO 5):

1. Explain how to securing the storage infrastructure.
2. Describe how to manage the storage infrastructure
3. Explain Data Warehousing with Oracle BI

Model Question Paper

Course Code: ITT418

Course Name: INFORMATION STORAGE MANAGEMENT

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Differentiate between Data and Big Data.
2. Write a short note on Stripping & mirroring
3. Describe the various type of FC Connectivity.
4. Describe the Components of FC SAN?
5. Explain the benefits of NAS?
6. Describe the key features of CAS.
7. Define Information Availability.
8. Explain the purposes of Backup?
9. List information security framework goals.
10. Describe the Challenges in Storage Infrastructure Management.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11	a.	Which are the essential software parts of a host system in a Data centre environment?	7
	b.	Write notes: read and write Operation with Cache.	7
		OR	
12	a.	Differentiate between Software RAID and Hardware RAID	5
	b.	What are the components of an Intelligent Storage System?	9

13	a.	Explain Fibre Channel Architecture.	9
	b.	Describe SAN based virtualization.	5
		OR	
14	a.	Explain FCoE and its Frame Structure.	7
	b.	List the components of iSCSI.	7
15	a.	Explain different type of NAS Implementations.	9
	b.	List the various NAS File Sharing Protocols?	5
		OR	
16	a.	Describe about Object-Based Storage Devices.	9
	b.	Explain the key components of Unified Storage	5
17	a.	Describe BC terminology and Planning lifecycle.	7
	b.	Explain backup topologies.	7
		OR	
18	a.	Explain various Local Replication Technologies.	7
	b.	Explain various Remote Replication Technologies.	7
19	a.	List the security implementations in SAN.	8
	b.	Write the components monitored in a Storage Infrastructure.	6
		OR	
20	a	How to secure storage infrastructure in NAS.	9
	b.	Describe the management activities in Storage Infrastructure.	5

Syllabus

Module 1 (7 Hours)
Data, Information, Evolution of storage architecture, Data center infrastructure, Information lifecycle. Data center environment: Application - Desktop - Memory virtualization RAID: Implementation - Methods - Levels, Intelligent storage system
Module 2(7 Hours)
Introduction to DAS and SCSI, SAN: Components - Connectivity options - Ports - FC architecture - Zoning - FC topologies, SAN based virtualization: Block level - VSAN, IP SAN: iSCSI - FCIP components - FCIP topology and frame structure, FCOE: Components – Benefits
Module 3:(7 Hours)
NAS: Benefits – Components - Implementations - File sharing protocols - I/O operations - Factors affecting NAS performance - File level virtualization, Object based storage: Operation Benefits - Fixed content and archives - Archive types, CAS: Architecture - Operations - Use cases, Unified storage.
Module 4 (7 Hours)
Introduction: Information availability - BC terminology - Planning lifecycle - Business impact analysis - Technology solutions, Backup and restore: Purposes - Methods - Architecture - Operations - SCB - Topologies - Targets - Deduplication, Local Replication: Terminology - Data consistency - Technologies - Restore and restart considerations,

Remote replication: Modes - Technologies - Advanced replication technologies.
Module 5(7 Hours)
Securing the storage infrastructure: Security terminology - Security framework – Risk triad - Security domains -Implementations - Managing the storage infrastructure: Monitoring - Activities - Challenges - Solutions Data Warehousing with Oracle BI

Text Books

1. Robert Spalding, Storage Networks: The Complete Reference, Tata McGraw Hill, New Delhi, 2006.
2. Somasundaram G, Alok Shrivastava, ISM – Storing, Managing and Protecting Digital Information, EMC Education Services, Wiley India, New Delhi, 2012.

Reference Books

1. Gerald J Kowalski, Mark T Maybury, Information Storage and Retrieval Systems: Theory and Implementation, BS Publications, New Delhi, 2009.
2. Marc Farley Osborne, "Building Storage Networks", Tata McGraw Hill, New Delhi, 2001.
3. Meeta Gupta, Storage Area Network Fundamentals, Pearson Education, New Delhi, 2002.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Module 1**	**7 Hours**
1.1	Data, Information, Evolution of storage architecture, Data centre infrastructure, Information lifecycle.	1
1.2	Data centre environment, Application, Desktop, Memory virtualization	2
1.3	RAID: Implementation, Methods, Levels.	2
1.4	Intelligent storage system	2
2	**Module 2**	**7 Hours**
2.1	Introduction to DAS and SCSI	1
2.2	SAN: Components	1
2.3	Connectivity options - Ports	1
2.4	FC architecture - Zoning, FC topologies	1
2.5	SAN based virtualization: Block level - VSAN, IP SAN iSCSI	1
2.6	FCIP components - FCIP topology and frame structure	1
2.7	FCOE: Components – Benefits.	1
3	**Module 3**	**7 Hours**
3.1	NAS: Benefits – Components - Implementations	1

3.2	File sharing protocols	1
3.3	I/O operations - Factors affecting NAS performance	1
3.4	File level virtualization,	1
3.5	Object based storage: Operation Benefits	1
3.6	Fixed content and archives - Archive types,	1
3.7	CAS: Architecture - Operations - Use cases, Unified storage.	1
4	**Module 4**	**7 Hours**
4.1	Information availability - BC terminology	1
4.2	Planning lifecycle	1
4.3	Business impact analysis - Technology solutions,	1
4.4	Backup and restore: Purposes - Methods - Architecture - Operations	1
4.5	SCB - Topologies - Targets - Deduplication, Local Replication: Terminology	1
4.6	Data consistency - Technologies - Restore and restart considerations,	1
4.7	Remote replication: Modes - Technologies - Advanced replication technologies.	1
5	**Module 5**	**7 Hours**
5.1	Securing the storage infrastructure:	1
5.2	Security terminology - Security framework	1
5.3	Risk triad - Security domains -Implementations	2
5.4	Managing the storage infrastructure: Monitoring	1
5.5	storage infrastructure Activities - Challenges, Solutions	1
5.6	Data Warehousing with Oracle BI	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT428	SOFTWARE QUALITY ASSURANCE	PEC	2	1	0	3

Preamble: This course aims at facilitating the student to understand basic tenets of software quality and quality factors, be exposed to the Software Quality Assurance (SQA) architecture and the details of SQA components and SQA plan.

Prerequisite: ITT 309 Management for software Engineers

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

CO NO.	Course Outcome (CO)	Bloom's Category
CO 1	Elaborate about software quality, software quality actors and SQA	Level 2: Understand
CO 2	Explain the pre project and SQA components and interpret the concepts of software testing and CASE tools	Level 2: Understand
CO 3	Describe software quality infrastructure and risk management	Level 2: Understand
CO 4	Identify the software quality metrics and SQA plan	Level 2: Understand
CO 5	Discuss about the quality standards, certification, assessment and organizing for quality assessment	Level 2: Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	-	-	-	-	-	-	-	-	-	1
CO 2	2	1	-	-	-	.	-	-	-	1	-	1
CO 3	2	1	-	-	-	.	-	-	-	-	-	1
CO 4	2	1	-	-	-	1	-	1	-	-	2	2
CO 5	2	1	-	-	-	-	-	1	1	1	-	1

3/2/1: high/medium/low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	20
Understand	80	80	80
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination(ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are software errors and faults?
2. What are the software quality factors?
3. Explain SQA system.

Course Outcome 2 (CO2)

1. Explain contract review.
2. Explain about software testing.

3. What are CASE tools?

Course Outcome 3(CO3):

1. Explain about templates and checklists.
2. Explain Configuration management and Documentation control.
3. Explain risk management.

Course Outcome 4 (CO4):

1. Explain process metrics and product metrics.
2. Explain cost of software quality.
3. Describe SQA planning.

Course Outcome 5 (CO5):

1. Explain different Quality management standards.
2. Explain the concept of organizing for Quality Assurance.

Model Question paper

Course Code: ITT428

Course Code: SOFTWARE QUALITY ASSURANCE

Max Marks:100 Duration: 3hr

PART A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Differentiate software errors, faults and failures.
2. Write note on human components in the SQA system.
3. Distinguish between verification and validation.
4. Explain the elements of quality plan.
5. What are templates?
6. Explain the human factors in risk management.
7. What are the limitations of software metrics?
8. What are the application of cost model?

9. Explain on CMMI.

10. What is the role of management in SQA?

PART B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11.	a.	Explain about McCall's Quality model.	9
	b.	What is the need for software quality requirements?	5
		OR	
12.	a.	Define SQA. What are its objectives?	4
	b.	Illustrate and explain the SQA architecture.	10
13.	a.	Explain the concepts of contract review.	7
	b.	What are the different strategies of software testing? Explain.	7
		OR	
14.	a.	Explain the Quality assurance activities in the development process	7
	b.	Briefly explain about CASE tools.	7
15.	a.	Explain about the corrective and preventive actions for quality control.	10
	b.	What are checklists?	4
		OR	
16.	a.	Describe in detail about documentation control.	8
	b.	Explain the different risk management roles.	6
		OR	
17.	a.	What are the components of project process control? Explain.	7
	b.	Explain the Classical quality cost model.	7
		OR	
18.	a.	Explain in detail about SQA plan.	14
19.	a.	What is Bootstrap methodology? Explain.	7
20.	b.	Discuss about the SQA units and other actors in SQA systems.	7

OR

21. a. Write a note on SPICE project. 10

b. Explain on IEEE software engineering standards. 4

Syllabus

Module 1 (7 Hours)
Introduction: Software quality -The software quality challenge – Software errors, faults and failures – Software quality assurance (SQA) – Definition and objectives. **Software quality factors**- Need and classification of software quality requirements- McCall's quality model – Software quality factors - Product operation, revision, transition – Alternate models - Software compliance with quality factors. **SQA system**- An SQA architecture – Pre-project components- Software Project life cycle Components– Infrastructure components for error prevention and improvement- Management components- Human components.
Module 2 (8 Hours)
Pre-project software quality components: Contract review - Development and quality plans **SQA components in the project life cycle-** Software Development methodologies – Quality assurance activities in the development process- Verification & Validation – Reviews. Software Testing –Definitions-Strategies- classification- Software Testing implementations – Quality of software maintenance components – Pre-Maintenance of software quality components – Quality assurance tools – CASE tools for software quality.
Module 3 (7 Hours)
Software quality infrastructure: Procedures and work instructions - Templates - Checklists- Staff training and certification. Corrective and preventive actions – Configuration management- Documentation control. **Risk Management:** Risk Management According to Standards and Models- Risk Management Roles- Human Factors and Risk Management.
Module 4 (8 Hours)
Management components of software quality: Project process control – Components – Implementation- Computerized tools. Software quality metrics – Objectives of quality measurement – Process metrics – Product metrics – Implementation – Limitations of software metrics Cost of software quality – Classical quality cost model – Extended model – Application of

Cost model. **Software Quality Assurance Plan :** SQA Planning- Executing SQAP
Module 5 (5 Hours)
Standards, certification and assessment: Quality management standards – ISO 9001 and ISO 9000-3 – capability Maturity Models – CMM and CMMI assessment methodologies - Bootstrap methodology – SPICE Project- ISO/IEC 15504 software process assessment standard. SQA project process standards –IEEE software engineering standards **Organizing for Quality Assurance**: Management and its role in software quality assurance- SQA units and other actors in SQA systems.

Text Books

1. Daniel Galin, Software Quality Assurance, Pearson Publication, 2009.
2. Claude Y. Laporte, Alain April, Software Quality Assurance, Wiley, IEEE Computer Society, Inc. 2018

Reference Books

1. Roger S Pressman, Software Engineering: A Practitioner's Approach, Seventh edition, Tata McGraw Hill.

Course Contents and Lecture Schedule

Sl. No	Topic	No. of Lectures
1	**Introduction**	**7 Hours**
1.1	**Introduction**: Software quality – The software quality challenge- Software errors, faults and failures – Software quality assurance (SQA) – Definition and objectives.	1
1.2	**Software quality factors**- Need and classification of software quality requirements- McCall's quality model –	1
1.3	Software quality factors - Product operation, revision, transition – Alternate models - Software compliance with quality factors.	2
1.4	**SQA system**- An SQA architecture	1
1.5	Pre-project components- Software Project life cycle Components– Infrastructure components for error prevention and improvement- Management components- Human components.	2
2	**Pre-project software quality components**	**8 Hours**
2.1	**Pre-project software quality components:** Contract review -	2

	Development and quality plans	
2.2	**SQA components in the project life cycle-** Software Development methodologies	1
2.3	Quality assurance activities in the development process- Verification & Validation – Reviews.	2
2.4	Software Testing –Definitions-Strategies- classification- Software Testing implementations –	1
2.5	Quality of software maintenance components – Pre-Maintenance of software quality components	1
2.6	Quality assurance tools – CASE tools for software quality.	1
3	**Software quality infrastructure & Risk Management**	**7 Hours**
3.1	**Software quality infrastructure**: Procedures and work instructions	1
3.2	Templates - Checklists	1
3.3	Staff training and certification. Corrective and preventive actions	2
3.4	Configuration management-.	1
3.5	**Risk Management:** Risk Management According to Standards and Models	1
3.6	Risk Management Roles- Human Factors and Risk Management.	1
4	**Management components of software quality & SQA**	**8 Hours**
4.1	**Management components of software quality:** Project process control – Components – Implementation- Computerized tools.	2
4.2	Software quality metrics – Objectives of quality measurement – Process metrics	1
4.3	Product metrics – Implementation – Limitations of software metrics	1
4.4	Cost of software quality – Classical quality cost model	1
4.5	Extended model – Application of Cost model.	1
4.6	**Software Quality Assurance Plan :** SQA Planning	1
4.7	Executing SQA	1
5	**Standards, certification and assessment & Organizing for Quality Assurance**	**5 Hours**
5.1	**Standards, certification and assessment:** Quality management standards – ISO 9001 and ISO 9000-3 – capability Maturity Models – CMM and CMMI assessment methodologies -	1
5.2	Bootstrap methodology – SPICE Project- ISO/IEC 15504 software process assessment standard.	1
5.3	SQA project process standards –IEEE software engineering standards	1

5.4	**Organizing for Quality Assurance**: Management and its role in software quality assurance-	1
5.5	SQA units and other actors in SQA systems.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT438	SOFTWARE ARCHITECTURE	PEC	2	1	0	3

Preamble: This course will help the students to understand the software architecture with quality attributes in depth. Various architectural patterns and evaluation methods are discussed in detail. The syllabus also focuses on architecting applications in cloud environments.

Prerequisite: ITT309–Management for Software Engineers, ITT202–Principles of Object Oriented Techniques

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

CO No:	Course Outcomes	BLOOM'S LEVEL
CO 1	Explain software architecture and recognize its importance, various contexts and the role of stakeholders	Level 2: Understand
CO 2	Describe the quality attributes of a software system	Level 2: Understand
CO 3	Summarize the knowledge of various architectural tactics and patterns.	Level 2: Understand
CO 4	Usearchitectural concepts in the design (ADD), implementation and testing phases of software project life cycle in agile projects	Level 3: Apply
CO 5	Interpretthe evaluation, economic analysis and documentation of architectures	Level 2: Understand

Mapping of course outcomes with program outcomes:

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	1	1	1	1	-	-	-	-	-	-	-	-
CO 2	2	2	1	2	-	1	-	-	-	-	-	-
CO 3	1	1	2	2	-	-	-	-	-	-	-	-
CO 4	1	2	2	2	-	-	-	-	-	-	-	-
CO 5	2	2	1	2	-	-	-	-	-	1	2	-

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	15	35
Understand	30	25	55
Apply		10	10
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define software architecture?
2. Why is software architecture important?
3. Describe architecture in a technical context
4. Describe architecture in a project life cycle context
5. Elaborate the role of different stakeholders in software architecture

Course Outcome 2 (CO2):

1. Describe the general scenario, tactics and the checklist for availability.
2. Why do software systems want to interoperate with each other?
3. Illustrate and explain the parameters for modifiability tactics.
4. How does resource management ensure performance?
5. How can we resist attacks on security.

Course Outcome 3(CO3):

1. Define architectural patterns
2. Explain the context, problem and solution of module patterns.

3. List a few popular architectures or platforms based on Broker pattern.
4. Illustrate the working of a Map-Reduce pattern with suitable diagram
5. Describe the relationship between tactics and patterns

Course Outcome 4 (CO4):

1. How would you employ the Agile practices of pair programming, frequent team interaction, and dedicated customer involvement in a distributed development environment?
2. Explain the Attribute Driven Design Method and its steps.
3. How can we make architecture and code consistent?
4. In embedded systems faults often occur "in the field" and it is difficult to capture and replicate the state of the system that led to its failure. What architectural mechanisms might you use to solve this problem?
5. Explain the different levels of testing and describe the role of architecture in each.

Course Outcome 5 (CO5):

1. Explain the evaluation of architecture using ATAM method
2. How can we document Software Architecture effectively?
3. Describe the CBAM method for economic analysis of architectures.
4. Discuss the architectural challenges in a cloud environment

Model Question paper

Corse Code : ITT438

Course Name: SOFTWARE ARCHITECTURE

Max.Marks :100 **Duration: 3 Hrs**

PART A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Describe the role of software architecture in project risk reduction.
2. List any three stakeholders for a system and their interests in the software architecture.
3. How do you calculate availability of a system?
4. Define three characteristics of security.
5. List the weaknesses of pipe and filter pattern.
6. Define layer bridging in layered pattern
7. Explain Context description in ADD .
8. Describe the term framework ?
9. Why do we use Utility –response curve?
10. List out the different deployment models in cloud.

PART B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11.	a.	List and explain the activities involved in creating a software architecture while developing a project	7
	b.	Explain the process recommendations for a good software architecture	7
		OR	
12.	a.	Discuss the technical context of software architecture.	7
	b.	How does the architecture help in carrying out the early design decisions?	7
13.	a.	Explain how faults can be recovered?	10
	b.	Define four tactics under detect attacks category.	4
		OR	
14.	a	Illustrate and describe the general scenario for modifiability	9
	b.	Describe manage interfaces tactics for interoperability.	5
15.	a.	Describe the SOA pattern.	8
	b.	List the weaknesses of broker pattern. How broker pattern can be improved with tactics?	6
		OR	
16.	a.	Describe how the MVC pattern separates the application functionality from the user interface functionality?	10
	b.	Give examples of systems that employ the publish-subscribe pattern.	4
17.	a.	Most user interface frameworks have some hooks and callbacks to the application specific functionality. How do these limitations affect the architectural implementation of the rest of the system?	9
	b.	How can you ensure consistency of code and architecture?	5
		OR	
18.	a.	Describe the principles of Incremental Commitment Model in agile projects.	7
	b.	Consider an online learning management system and illustrate how agile architecting can be done on the system.	7
19.		Explain the steps of ATAM evaluation method	14
		OR	
20.	a.	Describe the essential characteristics of cloud and the different service models	7
	b.	With block diagram, explain the architecture and allocation of cloud IaaS platform	7

Syllabus

Module 1 : Introduction (6 hours)
Introduction – Software architecture– importance of software architecture-Architecture in a technical context- Architecture in a project life cycle context, Role of stakeholders
Module 2 : Quality attributes (8 hours)
Quality attributes –Availability, Interoperability, Modifiability, Performance, Security.
Module 3 : Architecture Tactics and Patterns (8 hours)
Architecture Tactics and Patterns – Module patterns, Component and connector patterns, Allocation patterns, Relationship between tactics and patterns
Module 4 : Architecture in the agile project life cycle (6 hours)
Architecture in agile projects-The Attribute Driven Design Method-Architecture and implementation, Architecture and testing
Module 5: ATAM,CBAM, Cloud architecture, Architecture documentation (7 hours)
Architecture evaluation–Architecture Trade off Analysis Method-Documenting Software Architectures –Economic Analysis of Architectures- CBAM, Architecting in a cloud environment

Text Books

1. Len Bass, Paul Clements, and Rick Kazman., Software Architecture in Practice , Addison-Wesley Professional , 3rd Edition ,2012.

Reference Books

1. R.N. Taylor, N. Medvidovic, and E. M. Dashofy. Software Architecture: Foundations, Theory, and Practice, John Wiley & Sons, 2009.
2. Mary Shaw, David Garlan, Software architecture - perspectives on an emerging discipline, Prentice Hall, 1996

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction**	**6 Hours**
1.1	Introduction - Software architecture– importance of software architecture	2
1.2	Architecture in a technical context	1
1.3	Architecture in a project life cycle context	2
1.4	Role of stakeholders	1
2	**Quality attributes**	**8 Hours**
2.1	Availability – general scenario, tactics and design solution	2
2.2	Interoperability – general scenario, tactics and design solution	2
2.3	Modifiability – general scenario, tactics and design solution	2

2.4	Performance - tactics	1
2.5	Security - tactics	1
3	**Architecture Tactics and Patterns**	**8 Hours**
3.1	Architecture Tactics and Patterns – Module Patterns	2
3.2	Component and Connector Patterns	2
3.3	Allocation Patterns	2
3.4	Relationship between tactics and patterns	2
4	**Architecture in the project life cycle**	**6 Hours**
4.1	Architecture in agile projects	2
4.2	The Attribute Driven Design Method	2
4.3	Architecture and implementation	1
4.4	Architecture and testing	1
5	**ATAM,CBAM, Cloud architecture, Architecture documentation**	**7 Hours**
5.1	Architecture evaluation–Architecture Trade off Analysis Method	2
5.2	Documenting Software Architectures	1
5.3	Economic Analysis of Architectures- CBAM	2
5.4	Architecting in a cloud environment	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT448	NETWORK ON CHIP	PEC	2	1	0	3

Preamble: The syllabus is prepared as an introductory course in the area of Networks-on- Chip (NoC) design which equip the engineering graduates to learn the communication infrastructure between the many cores of a Multi-Processor System-on-Chip (MPSoC). The course covers the basic concepts in the implementation of Networks-on-Chip (NoC) technology in VLSI integration. The course introduces students to the benefits of the NoC paradigm and separating IP design and functionality from chip communication. It will also enhance the students' ability to use modular platforms for NoC design and performance analysis.

Prerequisite: ITT204 Computer Organization

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the basic concepts of NoC design.	Level 2: Understand
CO 2	Interpret the NoC topologies and MPSoC styles.	Level 2: Understand
CO 3	Categorize different routing algorithms and flow control on NoC with deadlock and livelock avoidance.	Level 3: Apply
CO 4	Interpret the microarchitecture of an NoC router.	Level 2: Understand
CO 5	Classify on-chip network workloads and familiarize the on-chip network simulators	Level 3: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	-	-	-	-	-	-	2
CO 2	2	3	3	2	-	-	-	-	-	-	-	2
CO 3	2	2	2	2	-	-	-	-	-	-	-	2
CO 4	3	2	2	2	-	-	-	-	-	-	-	2
CO 5	3	2	3	2	3	-	-	-	-	-	-	2

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	10	10	10
Level 2: Understand	35	30	70
Level 3: Apply	5	10	20
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have a maximum 2 subdivisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Discuss the building blocks of on-chip networks.
2. List the uses of interconnection networks.
3. Discuss the packet format used for processor-memory interconnect.

Course Outcome 2 (CO 2):

1. Differentiate ring and mesh on-chip network topology.
2. Explain with proper diagrams Multi-Processor System-on-Chip?
3. Can cache coherence protocol affect network performance? Illustrate.

Course Outcome 3 (CO 3):

1. Is XY routing minimal and deadlock free?
2. Discuss the taxonomy of routing protocols used in NoC.
3. Consider a 16-core TCMP machine in which cores are organized as regular square mesh topology. The system follows minimal west-first routing. How many unique minimal paths are there from 11 to 8? (Hint: core numbering starts from bottom left corner as 0 to top right corner.

Course Outcome 4 (CO 4):

1. Explain with a block diagram the architecture of an NoC router.
2. Describe the pipelined routing of a packet in a NoC based system.
3. Discuss the states associated with the input virtual channel of an NoC router.

Course Outcome 5 (CO 5):

1. Compare and contrast synthetic workloads and application-driven workloads.
2. Demonstrate the gem5 commands used to model a 4X4 mesh NoC with routing algorithm as XY routing running uniform-synthetic traffic with injection rate as 0.05.
3. When do we use SPEC CPU benchmarks while testing the NoC based system?

Model Question Paper

Course Code: ITT448
Course Name: NETWORK ON CHIP

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. List the uses of interconnection networks.
2. Describe the organization of Multi-Processor System-on-Chip.
3. Can cache coherence protocol affect network performance? Illustrate.
4. Define flit. Discuss the different types of flits and its relevance.
5. In an NoC based system the use of input buffers can increase the total bandwidth in the network. Discuss
6. Describe buffer back pressure.
7. Describe the relevance of average packet latency in an NoC based system.
8. How do we separate flits from credits?
9. Write a short note on Flex NoC.
10. What are the configurable elements in the garnet module of gem5. List its use.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11	a.	Explain the advantages and disadvantages of Multi-Processor System-on-Chip.	8
	b.	Compare Network-on-Chip interconnect with traditional bus.	6
		OR	
12	a.	Explain with a proper diagram the NoC paradigm.	9
	b.	Describe the challenges faced during the integration of different types of System-on-Chips.	5
13	a.	With a proper example, explain protocol level network deadlock.	8
	b.	What are the design-time metrics that are agnostic to the traffic flowing through the network.	6
		OR	
14	a.	Discuss in detail the impact of cache hierarchy on the performance of NoC based systems.	10
	b.	Write a short note on direct topologies used in NoC.	4
15	a.	With a proper example, explain the working of X-Y routing in a 4X4 mesh NoC.	10
	b.	Demonstrate the working of store and forward packet based flow control technique in NoC.	4
		OR	
16	a.	A packet is injected from router 4 with a destination address 14 in a 4x4 mesh interconnect network. It uses minimal west first routing. (Hint: core numbering starts from bottom left corner as 0 to top right corner as 15). How many outputport(s) are possible for this packet at the source router?	8
	b.	When do we go for wormhole switching? Illustrate with an example.	6
17	a.	Explain the types of router pipeline stalls in an NoC router.	8
	b.	Explain in detail various buffer organizations used in an NoC router.	6
		OR	
18	a.	Explain with a proper diagram round robin arbiter.	7
	b.	Demonstrate the phases of an NoC router with a proper diagram.	7
19	a.	Discuss the key metrics that are used to analyze the performance of a NoC based system.	8
	b.	Compare and contrast synthetic workloads and application-driven workloads.	6
		OR	
20	a	Write the steps to implement an 4x4 NoC in GARNET standalone model in gem5 simulator with topology as mesh, routing as XY, and explain how to identify the saturation point while analyzing the injection rate and latency values for the given system.	10
	b.	When do we use SPEC CPU benchmarks while testing the NoC based system.	4

Syllabus

Module 1: Introduction to SoC and interconnection networks (5 Hours)
Interconnection networks:-System-on-Chip integration and its challenges, SoC to Network-on-Chip: a paradigm shift, Research issues in NoC development, Existing NoC examples, Uses of interconnection networks - Processor-memory interconnect - I/O interconnect - Packet switching fabric - Network basics, A simple interconnection network - Network specifications and constraints - Topology - Routing - Flow control - Router design - Performance analysis. (refer T1 and T3)
Module 2: Interface with system architecture and topology (8 Hours)
Interface with system architecture:- Shared memory networks in chip multiprocessors - Impact of coherence protocol on network - Coherence protocol requirements for the on chip network - Protocol level network deadlock. Impact of cache hierarchy implementation on network performance - Home node and memory controller design issues - Miss and transaction status holding registers, Message passing, NoC interface standards. Topology:- Metrics - Traffic - Independent metrics - Traffic-dependent metrics, Direct topologies: rings, meshes, and tori, Indirect topologies: crossbars, butterflies. (refer T2)
Module 3: Routing algorithms & flow control (7 Hours)
Routing algorithms:- Taxonomy of routing algorithms, Deterministic routing algorithms, Adaptive routing - Basics - Minimal adaptive routing - Fully adaptive routing, Partially adaptive algorithms - Turn model. Flow control - Messages, Packets, Flits, Phits, Message-based flow control - Packet-based flow control - Flit-based flow control - Virtual channels - Deadlock-free flow control - Buffer backpressure - Implementation. (refer T1, T2, T4)
Module 4:Router microarchitecture (7 Hours)
Router architecture:- Basic router architecture, Block diagram, The router pipeline, stalls, Closing the loop with credits, Reallocating a channel, Speculation and lookahead, Flit and credit encoding. Buffers and virtual channels - Switch design - Allocators and arbiters. (refer T1 and T2)
Module 5: Performance analysis & simulation (8 Hours)
Performance analysis:- Measures of interconnection network performance, Throughput, Latency, Fault tolerance, Common measurement pitfalls, Analysis, Queuing theory validation. Simulation:-Levels of detail, Network workloads, Application-driven workloads - SPEC CPU benchmarks, Synthetic workloads - Uniform random, Bit-rotation, Bit-reverse, Bit-complement, Introduction to NoC simulator - gem5. Case study - FlexNoC. (refer T1 and T5)

Text Books

T1. William J. Dally, Brian P. Towles, Principles and Practices of Interconnection Networks, Elsevier, 2004.

T2. Natalie Enright Jerger, Tushar Krishna, Li-ShiuanPeh, On-Chip Networks, Synthesis Lectures On Computer Architecture, Morgan & Claypool, Second Edition, 2017.

T3. Santanu Kundu, SantanuChattopadhyay, Network-on-Chip: The Next Generation of System-on-Chip Integration, CRC Press, 2014.

T4. José Duato, Sudhakar Yalamanchili, Lionel Ni, Interconnection Networks: An Engineering Approach, Morgan Kaufmann, 2003.

T5. www.gem5.org

Reference Books

R1. A Jantsch and H. Tenhunen, Networks on Chip, Kluwer Academic Publishers, 2003.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Introduction to SoC and interconnection networks**	**5 Hours**
1.1	System-on-Chip integration and its challenges, SoC to Network-on-Chip: A paradigm shift	1
1.2	Uses of interconnection networks - Processor-memory interconnect-I/O interconnect.	1
1.3	Packet switching fabric - Network basics.	1
1.4	A Simple interconnection network - Network specifications and constraints - Topology - Routing - Flow control - Router design - Performance analysis.	1
1.5	Introduction to Network-on-Chip (NoC).	1
2	**Interface with system architecture and topology**	**8 Hours**
2.1	Shared memory networks in chip multiprocessors - Impact of coherence protocol on network	1
2.2	Coherence protocol requirements for the on chip network - Protocol level network deadlock	1
2.3	Impact of cache hierarchy implementation on network performance - Home node and memory controller design issues	1
2.4	Miss and transaction status holding registers, Message passing, NoC interface standards	1
2.5	Topology - Metrics - Traffic-independent metrics -Traffic-dependent metrics	1
2.6	Direct topologies: Rings, Meshes	1
2.7	Direct topology - Tori	1

2.8	Indirect topologies: Crossbars, Butterflies.	1
3	**Routing algorithms & flow control 7 Hours**	
3.1	Routing algorithms: Taxonomy of routing algorithms, Deterministic routing algorithms - XY routing	1
3.2	Adaptive routing - Basics - Minimal adaptive routing	1
3.3	Fully adaptive routing - Partially adaptive algorithms - Turn model - west-first	1
3.4	Flow control: Messages, Packets, Flits, Phits	1
3.5	Message-based flow control - Packet-based flow control	1
3.6	Flit-based flow control - Virtual channels	1
3.7	Implementation	1
4	**Router microarchitecture**	**7 Hours**
4.1	Router architecture: Basic router architecture, Block diagram	1
4.2	The router pipeline, Stalls	1
4.3	Closing the loop with credits, Reallocating a channel	1
4.4	Speculation and lookahead, Flit and credit encoding	1
4.5	Buffers and virtual channels	1
4.6	Switch design	1
4.7	Allocators and arbiters	1
5	**Performance analysis & simulation**	**8 Hours**
5.1	Performance analysis: Measures of interconnection network Performance, Throughput	1
5.2	Packet latency, Fault tolerance, Common measurement pitfall	1
5.3	Analysis, Queuing theory validation	1
5.4	Simulation: Levels of detail, Network workloads	1
5.5	Application-driven workloads - SPEC CPU benchmarks	1
5.6	Synthetic workloads - Uniform random, bit-rotation	1
5.7	Synthetic workloads - bit-reverse, bit-complement	1
5.8	Introduction to NoC simulator - gem5. Case study - FlexNoC.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT458	NATURAL LANGUAGE PROCESSING	PEC	2	1	0	3

Preamble: This course presents an introduction to the computational modelling of natural language. Topics covered include: computational morphology, language modelling and sequence tagging, syntactic parsing and compositional semantics, deep learning architecture for natural language processing with selected applications.

Prerequisite: ITT306 Data Science

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

CO No.	Course Outcome (CO)	Bloom's Category Levels
CO 1	Describethe fundamental concepts of Natural Language Processing	Level 2: Understand
CO 2	Discuss various linguistic and statistical features relevant to the basic NLP task, namely, spelling correction, morphological analysisand parts-of-speech tagging.	Level 2: Understand
CO 3	Explain different syntax and semantics approaches in NLP.	Level 2: Understand
CO 4	Describe deep learning architectures for sequence processing	Level 2: Understand
CO 5	Discussthe applications of natural language processing	Level 2: Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	-	-	-	-	-	-	-	-	-	-	1
CO 2	2	2	1	-	-	-	-	-	-	-	-	1
CO 3	2	2	-	-	-	-	-	-	-	-	-	1
CO 4	2	2	-	-	-	-	-	-	-	-	-	2
CO 5	2	2	2	-	-	-	-	-	-	-	-	2

3/2/1:High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous AssessmentTests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	40	40	80
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	Continuous Internal Evaluation(CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss various stages involved in NLP processes with suitable example.
2. Explain the need of preprocessing in NLP.
3. Describe Zipf's Law.

Course Outcome 2 (CO2):

1. Describe morphology? Why do we need to do morphological analysis?
2. Explain derivational and inflectional morphology in detail with suitable examples.
3. Describe the components of an HMM tagger.
4. Explain conditional random field taggers.

Course Outcome 3 (CO3):

1. Explain CFG with suitable example
2. Why semantic analysis is difficult?
3. What is parsing? Explain Top-down and Bottom-up approach of parsing with suitable examples.
4. Explain CYK algorithm
5. Discuss the disadvantages of probabilistic CFG

Course Outcome 4 (CO4):

1. Explain gradient descent algorithm?
2. Demonstrate an RNN architecture for Language modeling.
3. Describe the steps in training a neural network.
4. Explain the architecture of transformer model.

Course Outcome 5 (CO5):

1. Explain text summarization
2. Explain sentiment analysis
3. Discuss relation extraction and distant supervision in information extraction
4.

Model Question paper

Course Code*:* ITT458

Course Name: NATURAL LANGUAGE PROCESSING

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Describe the challenges of natural language processing?
2. Explain tokenization.
3. Explain N-gram language model.
4. Why CFG is used to represent natural language in parsing**.**
5. Describe distributional semantics.
6. Explain smoothing in language modelling?
7. Describe the different types of RNN?
8. Explain positional embedding?
9. Describe direct machine translation.
10. Explain sentiment analysis?

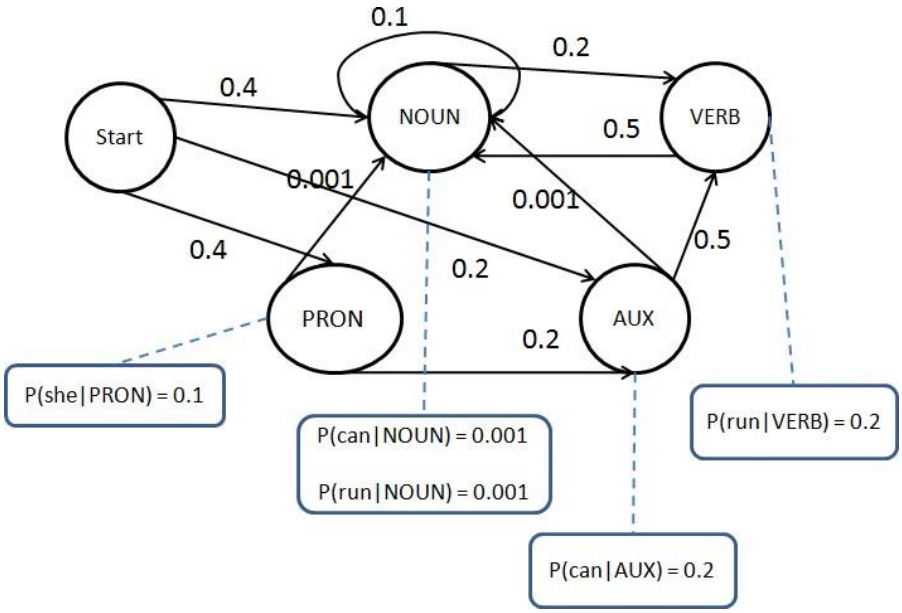
Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11. a. Explain Natural Language processing 4
    b. Discuss the various stages involved in NLP process with suitable examples 10

OR

12. a. Explain the minimum edit distance algorithm and compute the minimum edit distance between tumor and tutor 10
    b. Explain the difference between stemming and lemmatization. 4
13. a. Explain part-of -speech tagging 4
    b. For the given HMM, show the transition and emission probability matrices. Also calculate the probability of P(she|PRONcan|NOUNrun|NOUN).



10

OR

14. a. Explain the role of FSA in morphological analysis? 6
    b. Describe derivational and inflectional morphology in detail with suitable examples 8
15. a. Explain the significance of Word Sense Disambiguation in NLP. Describe any one WSD method 10
    b. Explain transition-based dependency parsing 4

OR

16. a. Explain distributional semantics and word embedding 6
    b. Derive a top-down, depth-first, left-to-right parse tree for the given sentence:
    The angry bear chased the frightened little squirrel
    Use the following grammar rules to create the parse tree: 8

S → NP VP	Det → the
NP → Det Nom	Adj→ little | angry | frightened
VP → V NP	N → squirrel | bear
Nom →Adj Nom | N	V → chased

17. a. Explain the four types of sequence-to-sequence modeling with example. 8
    b. Describe gradient descent algorithm 6

OR

18. a. Explain the architecture of LSTM. 8
    b. Illustrate how transformer can be trained as a language model 6
19. a. Describe beam search 4
    b. Explain how transformers can be used for text summarization 10

OR

20. a. Explain distance supervision for information extraction. 4
    b. Describe the encoder decoder model for machine translation 10

Syllabus

Module 1 : Introduction to NLP and Text Processing Basics (5 Hours)
Introduction to NLP, Levels of NLP, Difficulties in NLP, Empirical Laws -Heap's Law, Zipf's Law, Type-Token Ratio, Basic Text Processing: Tokenization, Stemming & Lemmatization, Spelling Correction.
Module 2: Language Modelling and Sequence Tagging (7 Hours)
Language Modelling and Smoothing: N-Gram Language Model, Language Model Evaluation: Basic Smoothing, Advanced Smoothing Models, Morphology, Finite State Methods for Morphology, Part of Speech Tagging, Hidden Markov Model Models for POS Tagging, Maximum Entropy Models, Conditional Random Fields
Module 3: Syntax and Semantics (9 Hours)
Constituency Grammars- Context-Free Grammars, Treebanks, Constituency Parsing- PCFGs and CKY Parsing, Dependency Parsing- Dependency Relations, Dependency Formalisms, Dependency Treebanks, Transition-Based Dependency Parsing, Graph-Based Dependency Parsing Distributional Semantics, Distributional Models of Semantics, Word Embeddings, Lexical Semantics, WordNet, Word Sense Disambiguation
Module 4:Deep Learning Architectures for Sequence Processing (7 Hours)
Introduction to Neural Networks, Neural Language Models, Recurrent Neural Networks, RNN as Language Models, RNN for Sequence Labelling and Sequence Classification, Generation with RNN-based Language Models, Stacked and Bidirectional RNN architectures, Long short-term

memory, Gated Recurrent Units, Attention Mechanism, Transformers, Transformers as Language Models
Module 5 :Applications (7 Hours)
Encoder–Decoder Model for Neural Machine Translation, RNN based Machine Translation, Introduction to Attention Based Translation, Information Extraction, Text Summarization, Sentiment Analysis

Text Books

1. Jurafsky and Martin, Speech and Language Processing, Pearson Prentice Hall, Third Edition, 2018.
2. Daniel Jurafsky, James H. Martin, Speech and Language Processing", Prentice Hall, Second Edition,2008
3. Christopher D. Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

Reference Books

1. Stevan Bird, Natural Language Processing with Python, Shroff, 2009.
2. James Allen, Natural Language Understanding, Addison Wesley, Second Edition, 2007.
3. Nitin Indurkhya, Fred J. Damerau, Handbook of Natural Language Processing, Chapman & Hall/CRC Machine Learning & Pattern Recognition, Second Edition, 2010.
4. Alexander Clark, Chris Fox, Shalom Lappin, The Handbook of Computational Linguistics and Natural Language Processing, Wiley-Blackwell, 2012.
5. Ian Goodfellow, YoshuaBengo, Aaron Courville, Deep Learning, MIT Press, First Edition 2017
6. https://web.stanford.edu/~jurafsky/slp3/
7. https://nptel.ac.in/courses/106105158
8. https://nptel.ac.in/courses/106106211
9. https://www.coursera.org/specializations/natural-language-processing

Course Contents and Lecture Schedule

SlNo.	Topic	No. of Lectures
1	**Introduction to NLP and Text Processing Basics**	**5 Hours**
1.1	Introduction to NLP, Levels of NLP	1
1.2	Why NLP is hard –Lexical Ambiguity, Structural Ambiguity, Language impression and vagueness	1
1.3	Empirical Laws -Heap's Law, Zipf's Law, Type-Token Ratio,	1
1.4	Basic Text Processing: Tokenization, Stemming& Lemmatization	1

1.5	Spelling Correction –Edit Distance	1
2	**Language Modelling and Sequence Tagging**	**7 Hours**
2.1	N-Gram Language Model, Language Model Evaluation, Basic Smoothing	1
2.2	Advanced Smoothing Models	1
2.3	Computational Morphology, Finite State Methods for Morphology	1
2.4	Introduction to Part of Speech Tagging, Hidden Markov Model Models for POS Tagging	1
2.5	Veterbi Decoding for HMM, Baum Welch Algorithm	1
2.6	Maximum Entropy Models	1
2.7	Conditional Random Fields	1
3	**Syntax and Semantics**	**9 hours**
3.1	Constituency Grammars-Context-free grammars, Treebanks	1
3.2	Constituency Parsing- PCFGs and CKY Parsing	1
3.3	Dependency Parsing–Dependency Relations, Dependency Formalisms, Dependency Treebanks	1
3.4	Transition-Based Dependency Parsing	1
3.5	Graph-Based Dependency Parsing	1
3.6	Distributional Semantics , Distributional Models of Semantics - One hot encoding, Distributional Representation, Tf-Idf, Pointwise Mutual Information	1
3.7	Word Embeddings	1
3.8	Lexical Semantics , WordNet	1
3.9	Word Sense Disambiguation	1
4	**Deep Learning Architectures for Sequence Processing**	**7 Hours**
4.1	Introduction to Neural Networks, Backpropagation	1
4.2	Neural Language Models	1
4.2	Recurrent Neural Networks, RNN as Language Models	1
4.3	RNN for Sequence Labelling and Sequence Classification, Generation with RNN-based Language Models	1
4.4	Stacked and Bidirectional RNN architectures	1
4.5	Long short-term memory ,Gated Recurrent Units	1
4.6	Attention Mechanism, Transformers	1
4.7	Transformers as language models	1
5	**Application**	**7 Hours**

5.1	Encoder–Decoder Model for Neural Machine Translation	1
5.2	RNN based Machine Translation	1
5.3	Introduction to Attention Based Translation	1
5.4	Information Extraction : Relation Extraction	1
5.5	Information Extraction : Distant Supervision	1
5.6	Text Summarization using transformers	1
5.7	Sentiment Analysis using RNN	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT468	BIO-INFORMATICS	PEC	2	1	0	3

Preamble: The syllabus is prepared with a view to equip the Engineering Graduates to learn basic concepts in molecular biology, and to in still the confidence to develop algorithms for efficient analysis of biological data.

Prerequisite: Nil

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Define basic concepts in molecular biology and familiarize biological databases	Level 2: Understand
CO 2	Discuss various algorithms and tools for performing sequence alignment	Level 2: Understand
CO 3	Illustrate various algorithms for the construction of phylogenetic trees	Level 3: Apply
CO 4	Discuss various algorithms for predicting protein and RNA secondary structure	Level 2: Understand
CO 5	Explian gene expression profiling and epigenetic gene regulation	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	1	-	-	-	-	-	-	-	3
CO 2	3	2	2	1	-	-	-	-	2	-	-	3
CO 3	2	3	3	1	-	-	-	-	-	-	-	-
CO 4	2	2	2	1	-	-	-	-	-	-	-	-
CO 5	3	2	2	1	-	-	-	-	2	-	-	3

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
BL 1: Remember	10	10	10
BL 2: Understand	35	35	75
BL 3: Apply	5	5	15
BL 4: Analyze			
BL 5: Evaluate			
BL 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
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End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. What are codons? Give the triplet code for start and stop codons.
2. List any five applications of data mining in bioinformatics.

Course Outcome 2 (CO 2):

1. Given two DNA sequences ATCGGTA and ACTGTAT, compute the partial alignment score table between these two sequences using the Needleman-Wunsch algorithm. Use match score +5, mismatch score -1 and gap penalty -2.
2. Differentiate local and global sequence alignment methods.

Course Outcome 3 (CO 3):

1. What is Phylogenetic analysis? Explain in steps in constructing a phylogenetic tree using UPGMA method.
2. State the applications of HMM in bioinformatics. Apply the forward algorithm used in HMM to predict missing symbols in a given sequence.

Course Outcome 4 (CO 4):

1. Why is gene regulation required? Explain any two gene expression profiling techniques.
2. The sequence of the coding strand in a transcription unit is written as follows 5'GCATGCATGCATGCATGCATGCAT3'. Write down the sequence of its mRNA.

Course Outcome 5 (CO 5):

1. What is epigenetic regulation? Explain any three kinds of epgenetic modifications in detail.
2. Explain the significance of pathway analysis.

Model Question Paper

Course Code: ITT468

Course Name: BIO-INFORMATICS

Max.Marks:100 **Duration: 3 Hours**

Part A

Answer all questions. Each question carries 4 marks. (10 * 3 = 30 Marks)

1. Differentiate Bioinformatics and Computational Biology.
2. Explain how microarrays can be used for gene expression profiling.
3. If a double stranded DNA has 40% of cytosine, calculate the percentage of adenine in DNA.
4. Give the features of any three variants of BLAST tool.
5. What are the functions of mRNA, tRNA and rRNA?
6. Justify the statement: "Structure of a Protein determines its functionality".
7. What is sequence alignment? Mention any two tools for performing DNA sequence alignment.
8. List the applications of HMM in bioinformatics.
9. What are CpG islands?
10. Mention any two ways in which gene expression profiling can be applied to identify disease causing genes.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11. a. With the help of a diagram explain the concept of central dogma of molecular biology. 8

    b. Explain the significance of BLOSUM matrix? 6

OR

12. a. Write short notes on (i) EMBL (ii) PDB (iii) Entrez 6

    b. Explain the various application areas of Bioinformatics. 8

13. a. Using the Needleman and Wunsch dynamic programming method, construct the partial alignment score matrix and scoring matrix for the given two sequences, using the following scoring policy: match score=+3, mismatch score=-1, gap penalty =-2.

    ACAGTCGAACG

    ACCGTCCG

    What is the optimal global alignment and score between sequences? 9

    b. How can we evaluate alignment of long multiple sequences? 5

OR

14. a. Compare PAM and BLOSUM matrices. 8

    b. BLAST and FASTA are two widely used tools for sequence alignment. Compare the similarities and differences in their approach. 6

OR

15. a. Explain character-based phylogenetic tree construction with an example. 6

    b. Use UPGMA to reconstruct a phylogenetic tree using the following distance matrix:

8

OR

16. a. What is phylogenetic analysis? Explain the Neighbour-Joining method of phylogenetic analysis. 8

	b.	Explain the Maximum Parsimony algorithm for phylogenetic trees.	6
17.	a.	Explain the Chou-Fasman method for predicting the secondary structure of proteins.	8
	b.	Explain the features of regular protein secondary structures of alpha helix and beta pleated sheet.	6
		OR	
18.	a.	Explain Nussinov algorithm for RNA secondary structure prediction with an example.	8
	b.	Explain the lattice models for protein folding.	6
19.	a.	Explain with an example, the forward algorithm for HMMs.	6
	b.	What is gene regulation? Explain any two gene expression profiling techniques in detail.	8
		OR	
20.	a.	What do you mean by Gene prediction? Explain the different strategies for Gene Prediction.	8
	b.	What is epigenetics? Explain any three different epigenetic modifications in detail.	6

Syllabus

Module 1: Introduction to Molecular Biology and Biological Databases (6 Hours)
Computational Biology and Bioinformatics – scope, Introduction to Molecular biology – Central Dogma, DNA and RNA structure, coding and non-coding RNAs, Genetic codes, Evolution Biological Databases - Types of databases, Nucleic acid sequence databases – GenBank, DDBJ, EMBL, Protein sequence databases – SwissProt, UniProt, PDB
Module 2: Sequence Alignment (8 Hours)
Sequence Alignment – local/global, FASTA files, Algorithms for pairwise sequence alignment – Needleman and Wunsch, BLAST and its variants, Gaps and Scoring Matrices – basic concepts, construction, PAM and BLOSUM series, Multiple Sequence Alignment – CLUSTAL and its variants
Module 3: Molecular Phylogenetics(7 Hours)
Phylogenetic trees, Topologies, Distance based and Character based tree construction, Algorithms for Phylogenetic tree construction – UPGMA, Neighbor-Joining, Maximum Parsimony
Module 4: Protein and RNA Structure Prediction (8 Hours)
Introduction to Protein structure, Amino acids and Polypeptide Composition, Algorithms for Protein secondary structure prediction – Chou-Fasman, Protein Folding – Lattice models, Algorithms for predicting RNA secondary structure – Nussinov's algorithm

Module 5:Gene Expression and Pattern Matching (6 Hours)
Gene expression, Micro Arrays, NGS, Pathways, Algorithms for pattern matching – HMM, Forward algorithm, Gene Prediction, Epigenetics – basic concept, Types of epigenetic modifications, CpG islands

Text Books

1. D. E. Krane and M. L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 1/e, 2003
2. N Gautham, Bioinformatics Databases and Algorithms, Narosa Publications, 2006
3. Neil C Jones and Pavel A Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, 2004

Reference Books

1. T. K. Attwood and D. J. Parry-Smith, Introduction to Bioinformatics, Pearson Education, 2003.
2. Arthur M Lesk, Introduction to Bioinformatics, Oxford University Press, 2002
3. Jean Michel Claverie and Cedric Notredame, Bioinformatics – A Beginner's guide, Wiley-Dreamtech India Pvt. Ltd., 2003

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Introduction to Molecular Biology and Biological Databases**	**6 Hours**
1.1	Computational Biology and Bioinformatics – scope, Introduction to Molecular biology – Central Dogma	1
1.2	DNA and RNA structure, coding and non-coding RNAs	1
1.3	Genetic codes, Evolution	1
1.4	Biological Databases - Types of databases, Nucleic acid sequence databases – GenBank, DDBJ, EMBL	2
1.5	Protein sequence databases – SwissProt, UniProt, PDB	1
2	**Sequence Alignment**	**8 Hours**
2.1	Sequence Alignment – local/global, FASTA files	1
2.2	Algorithms for pairwise sequence alignment – Needleman and Wunsch	2
2.3	BLAST and its variants	1
2.4	Gaps and Scoring Matrices – basic concepts, construction,	1
2.5	PAM and BLOSUM series	1

2.6	Multiple Sequence Alignment – CLUSTAL and its variants	2
3	**Molecular Phylogenetics**	**7 Hours**
3.1	Phylogenetic trees, Topologies	1
3.2	Distance based and Character based tree construction	1
3.3	Algorithms for Phylogenetic tree construction – UPGMA	2
3.4	Neighbor-Joining algorithm	2
3.5	Maximum Parsimony algorithms	1
4	**Protein and RNA Structure Prediction**	**8 Hours**
4.1	Introduction to Protein structure	1
4.2	Amino acids and Polypeptide Composition	1
4.3	Algorithms for Protein secondary structure prediction – Chou-Fasman	2
4.4	Protein Folding – Lattice models	1
4.5	Algorithms for predicting RNA secondary structure	1
4.6	Nussinov's algorithm	2
5	**Gene Expression and Pattern Matching**	**6 Hours**
5.1	Gene expression, Micro Arrays	1
5.2	NGS, Pathways	1
5.3	Algorithms for pattern matching – HMM	1
5.4	Forward algorithm, Gene Prediction	1
5.5	Epigenetics – basic concept	1
5.6	Types of epigenetic modifications, CpG islands	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITT478	DEEP LEARNING	PEC	2	1	0	3

Preamble: The syllabus is prepared with a view to equip the Engineering Graduates to learn fundamentals of deep learning and machine learning, and to design and build efficient deep learning models.

Prerequisite: Nil

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the fundamentals of linear algebra and probability required to understand machine/deep learning techniques.	Level 2: Understand
CO 2	Compare various supervised and unsupervised machine learning techniques for better decision making	Level 2: Understand
CO 3	Describe optimization techniques for building efficient machine/deep learning models	Level 2: Understand
CO 4	Demonstrate building of various deep learning models	Level 3: Apply
CO 5	Implement machine/deep learning models to solve typical problems	Level 3: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	-	-	-	-	-	-	-
CO 2	3	3	3	3	2	1	-	-	1	-	-	1
CO 3	2	2	2	1	-	-	-	-	-	-	-	1
CO 4	3	3	3	3	3	-	-	1	-	-	-	1
CO 5	3	3	3	3	3	-	-	1	-	-	-	1

3/2/1: High/Medium/Low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

Bloom's Category Levels	Continuous Assessment Tests		End Semester Examination
	1	2	
Level 1: Remember	10	10	10
Level 2: Understand	40	30	70
Level 3: Apply		10	30
Level 4: Analyse			
Level 5: Evaluate			
Level 6: Create			

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Define the inverse and transpose of a matrix.
2. What are identity matrix, upper triangular matrix and orthogonal matrix?
3. Define variance and covariance of a random variable
4. What is Eigen decomposition?

Course Outcome 2 (CO 2):

1. Compare Decision tree and Random Forest classifiers?
2. How k-means clustering method is different from hierarchical clustering?

3. Demonstrate with an example how ANN can solve a non-linear classification problem.

4. Demonstrate how Area under ROC can be used for model selection.

Course Outcome 3 (CO 3):

1. Define the need for gradient based optimization
2. Explain the significance of learning rate in gradient descent optimization
3. Discuss the batch, and mini-batch gradient descent algorithms
4. Distinguish between batch and stochastic gradient descent algorithms

Course Outcome 4 (CO 4):

1. Draw the general architecture diagram of a deep learning model that can be used for machine translation
2. Demonstrate how a CNN network can be used to derive a one dimensional feature vector from a given image data.
3. Demonstrate max pooling and average pooling and explain how their results can influence the final model
4. Demonstrate the advantage of using bidirectional RNNs for text processing

Course Outcome 5 (CO 5):

1. Draw the architecture of a transfer learning model and discuss how it can be used for another solving another problem.
2. Assume you are given a set of sentences in a language and demonstrate how to build a deep learning model to predict these sentences expressing positive or negative sentiment.
3. Demonstrate how a CNN model can be used to solve the handwritten character recognition problem

Model Question Paper

Course Code: ITT478

Course Name: DEEP LEARNING

Max.Marks :100 **Duration: 3 Hrs**

Part A

Answer all questions. Each question carries 3 marks (10 * 3 = 30 Marks)

1. Explain vector multiplication of dot product and cross product with suitable examples.
2. Describe linear least square optimization.
3. Write the stochastic gradient descent algorithm.

4. For a 3-2-1 multilayer neural network, demonstrate how output value is calculated in the feed forward step for a given input feature vector. Assume initial weight values and activation functions of your choice.
5. Explain any 3 activation functions with their graphical representations.
6. Describe the LeNet-5 CNN architecture.
7. Explain the vanishing/exploding gradient with respect to RNNs.
8. Describe the LSTM network.
9. Explain the working of Generative Adversarial Network.
10. Describe an application of transfer learning.

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11		Describe gradient based optimization and constrained optimization with suitable examples.	14

OR

12	a	Describe Principle Component Analysis and its significance in Machine learning	8
	b	Define the following: (1) Marginal and conditional probabilities (2) Chain rule and (3) Bayes rule	6
13	a	Demonstrate how linear regression technique can be used to predict the Systolic blood pressure of person if weight is given. You may create a sample dataset for 10 persons and predict it for a given person with weight 85kg.	10
	b	Explain confusion matrix and its role in machine learning model building.	4

OR

14	a	Explain how a Support Vector Machine model classifies a given input feature vector. Illustrate with an example also.	8
	b	Describe the DBSCAN method of density based clustering.	6
15	a	Explain the convolution and pooling operations with suitable examples	8
	b	Describe the AlexNet CNN architecture.	6

OR

16		Describe the feed forward step in the learning of a CNN model for a binary classification. You may createa minimal CNN model with 3 stacked layers and a final fully connected layer, with activation functions and other parameters of your choice. Clearly show how the output is calculated for a	14

given input.

17	a	Explain different types of RNNs with their architectures and one application for each of them.	8
	b	Explain Gated Recurrent Unit and its usage.	6

OR

18	a	Demonstrate the working of a Bidirectional RNN with an example.	10
	b	Explain Deep Recurrent Networks	4
19	a	Explain the working principle of Autoencoders	5
	b	Explain how transfer learning can be used to solve a NLP problem with an example.	9

OR

20	a	Explain how transfer learning can be used to solve an image processing problem with an example.	9
	b	Explain the working principle of Generative Adversarial Networks	5

Syllabus

Module 1: Basics of Linear Algebra, Probability and Numerical Computation (6 Hours)
Linear Algebra:– Scalars, Vectors, Matrices and Tensors, Matrix and Vector operations, Types of matrices and vectors, Eigen Decomposition, Principal Component Analysis
Probability: - Random Variables, Probability Distributions, Marginal and Conditional Probabilities, Chain rule, Independence and Conditional independence, Expectation, Variance and Covariance, Bayes rule
Gradient based optimization, Constrained optimization, Linear Least Squares
Module 2: Machine Learning Basics (11 Hours)
Introduction to Learning algorithms:- - Types of learning algorithms - Supervised, Unsupervised, Reinforcement – Overfitting, Underfitting, Hyperparameters and Validation sets, Stochastic Gradient Descent.
Supervised learning algorithms: – Linear Regression, Logistic Regression, Naive Bayes, Decision Tree, Artificial Neural Networks, Support Vector Machines, Random Forest, Ensemble methods. Performance metrics:- Mean Squared Error, Mean Absolute Error, Root Mean Squared Error, Accuracy, Confusion matrix, Precision, Recall, F1-score and Area Under Receiver Operating Characteristics Curve
Unsupervised learning algorithms:- K-means clustering, Hierarchical clustering, Density based clustering
Module 3: Deep Learning Networks – ConvolutionalNetworks (6 Hours)

Challenges motivating Deep learning, Deep Forward Networks, Gradient based learning, Back propagation, Activation functions.
Convolution operation, Pooling, Variants of basic convolution function, Convolutional Neural Networks (CNN) – Convolution layer, Pooling layer, Fully connected layer – Types of CNNs – LeNet-5, AlexNet, ResNet
Module 4: Deep Learning Networks – Recurrent Networks (6 Hours)
Recurrent Neural Networks (RNN), Types of RNN – One-to-One, One-to-Many, Many-to-One, Many-to-Many – Vanishing/Exploding Gradient, Gated Recurrent Unit, Long-Short Term Memory Unit, LSTM Network, Bidirectional RNNs, Deep Recurrent Networks
Module 5: Deep Learning Networks – Advanced Topics and Applications (6 Hours)
Advanced Topics: - Basics of Autoencoders, Generative Adversarial Networks Applications: Building of deep learning models for Image Processing and Natural Language Processing using Deep Learning Networks, including Transfer Learning.

Text Books

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press, 1stEdition, 2016
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 1st Edition, 2006
3. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, Wiley-Interscience, 2nd Edition, 2000

Reference Books

1. Charu C Aggarwal, Neural Networks and Deep Learning – A Textbook, Springer, 1st Edition, 2018
2. Charu C Aggarwal, Linear Algebra and Optimization for Machine Learning – A Textbook, Springer, 1st Edition, 2020
3. Francois Chollet, Deep Learning with Python, Manning, 1st Edition, 2017

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Basics of Linear Algebra, Probability and Numerical Computation**	**6 Hours**
1.1	Linear Algebra:– Scalars, Vectors, Matrices and Tensors, Matrix and Vector operations	1
1.2	Types of matrices and vectors	1
1.3	Eigen Decomposition, Principal Component Analysis	1
1.4	Probability: - Random Variables, Probability Distributions, Marginal and Conditional Probabilities, Chain rule, Independence and Conditional independence	1
1.5	Expectation, Variance and Covariance, Bayes rule	1
1.6	Gradient based optimization, Constrained optimization, Linear Least Squares	1
2	**Machine Learning Basics**	**11 Hours**
2.1	Introduction to Learning algorithms:- - Types of learning algorithms - Supervised, Unsupervised, Reinforcement	1
2.2	Overfitting, Underfitting, Hyperparameters and Validation sets,	1
2.3	Stochastic Gradient Descent	1
2.4	Supervised learning algorithms: – Linear Regression	1
2.5	Logistic Regression, Naive Bayes	1
2.6	Decision Tree	1
2.7	Artificial Neural Networks	1
2.8	Support Vector Machines	1
2.9	Random Forest, Ensemble Methods	1
2.10	Performance metrics:- Mean Squared Error, Mean Absolute Error, Root Mean Squared Error, Accuracy, Confusion matrix	1
2.11	Precision, Recall, F1-score and Area Under Receiver Operating Characteristics Curve	1
3	**Deep Learning Networks – Convolutional Networks**	**6 Hours**
3.1	Challenges motivating Deep learning, Deep Forward Networks, Gradient based learning	1
3.2	Back propagation, Activation functions.	1
3.3	Convolution operation, Pooling, Variants of basic convolution function	1
3.4	Convolutional Neural Networks (CNN) – Convolution layer, Pooling	1

	layer, Fully connected layer	
3.5	Types of CNNs – LeNet-5	1
3.6	AlexNet, ResNet	1
4	**Deep Learning Networks – Recurrent Networks**	**6 Hours**
4.1	Recurrent Neural Networks (RNN), Types of RNN – One-to-One, One-to-Many,	1
4.2	Types of RNN - Many-to-One, Many-to-Many	1
4.3	Vanishing/Exploding Gradient, Gated Recurrent Unit	1
4.4	Long-Short Term Memory Unit, LSTM Network	1
4.5	Bidirectional RNNs	1
4.6	Deep Recurrent Networks	1
5	**Deep Learning Networks – Advanced Topics and Applications**	**6 Hours**
5.1	Basics of Autoencoders	1
5.2	Basics of Generative Adversarial Networks	1
5.3	Building of deep learning models for Image Processing	1
5.4	Building of deep learning models for Image Processing (transfer learning)	1
5.5	Building of deep learning models for Natural Language Processing	1
5.6	Building of deep learning models for Natural Language Processing (transfer learning)	1

ITT404	COMPREHENSIVE COURSE VIVA	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : 25 Marks

ITD416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

The COs and CO-PO map shall be considered as suggestive only.

Abstract POs defined by National Board Of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. .[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual’s presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual’s performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

SEMESTER VIII

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITD482	MINIPROJECT	PWS	0	0	3	2

Preamble: This course is designed for enabling the students to apply the knowledge to address the real-world situations/problems and find solutions. The course is also intended to estimate the ability of the students in transforming theoretical knowledge studied as part of the curriculum so far in to a working model of a software system. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Prerequisites: Subjects studied up to sixth semester.

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Make use of acquired knowledge within the selected area of technology for project development.	Level 3: Apply
CO 2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.	Level 3: Apply
CO 3	Interpret, improve and refine technical aspects for engineering projects.	Level 3: Apply
CO 4	Associate with a team as an effective team player for the development of technical projects.	Level 3: Apply
CO 5	Report effectively the project related activities and findings.	Level 2: Understand

Mapping of course outcomes with program outcomes

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	3	3	3	3	-	-	-	3
CO 2	3	3	3	3	3	-	2	3	-	3	2	3
CO 3	3	3	3	3	3	2	3	3	-	2	3	3
CO 4	3	3	2	2	-	-	-	3	3	3	3	3
CO 5	3	-	-	-	2	-	-	3	2	3	2	3

3/2/1: high/medium/low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systems under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.
(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews**.**

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

SEMESTER VIII

HONOURS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ITD496	MINIPROJECT	PWS	0	0	3	2

Preamble: This course is designed for enabling the students to apply the knowledge to address the real-world situations/problems and find solutions. The course is also intended to estimate the ability of the students in transforming theoretical knowledge studied as part of the curriculum so far in to a working model of a software system. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Prerequisites: Subjects studied up to sixth semester.

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Make use of acquired knowledge within the selected area of technology for project development.	Level 3: Apply
CO 2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.	Level 3: Apply
CO 3	Interpret, improve and refine technical aspects for engineering projects.	Level 3: Apply
CO 4	Associate with a team as an effective team player for the development of technical projects.	Level 3: Apply
CO 5	Report effectively the project related activities and findings.	Level 2: Understand

Mapping of course outcomes with program outcomes

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	3	3	3	3	-	-	-	3
CO 2	3	3	3	3	3	-	2	3	-	3	2	3
CO 3	3	3	3	3	3	2	3	3	-	2	3	3
CO 4	3	3	2	2	-	-	-	3	3	3	3	3
CO 5	3	-	-	-	2	-	-	3	2	3	2	3

3/2/1: high/medium/low

The COs and CO-PO map shall be considered as suggestive only.

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systems under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:
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Project Report : 10 marks
Evaluation by the Committee : 40 Marks

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(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

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The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.