SEMESTER V

SCHEME : B TECH -2019

PROGRAMME : ELECTRONICS AND COMPUTER ENGINEERING

ERT 301	DIGITAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to provide an understanding of the principles, algorithms an Applications of Digital Signal Processing.

Prerequisites: Linear Algebra

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

CO 1	Summarize the fundamental concepts of discrete-time signals and systems and obtain the transfer function of system using Z-transform. **(Cognitive Knowledge Level: Understand)**
CO 2	Illustrate thefundamental concepts of DFT and compute DFT and IDFT. **(Cognitive Knowledge Level: Understand)**
CO 3	Design FIR filters and IIR filters for the given specifications. **(Cognitive Knowledge Level: Apply)**
CO 4	Realize the various FIR and IIR filter structures for given the system function. **(Cognitive Knowledge Level: Apply)**
CO 5	Explain the architecture of DSP processor (TMS320C67xx) and the finite word length effects in digital filtering. **(Cognitive Knowledge Level: 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
CO1	✓	✓	✓		✓							✓
CO2	✓	✓	✓		✓							✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓							✓
CO5	✓	✓	✓		✓							✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	2	
Remember	K1	10	10	20
Understand	K2	20	20	40
Apply	K3	20	20	40
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Tutorial : 15marks

Internal Examination Pattern: Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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

CO 1: Summarize the fundamental concepts of discrete-time signals and systems and obtain the transfer function of system using Z-transform.

(i) Discuss the elementary discrete time signals

(ii) A discrete time LTI system is given by $y[n]-\frac{1}{2}y[n-1]=x[n]+x[n-1]$. Determine the transfer function of the system

CO 2: Illustrate the fundamental concepts of DFT and compute DFT and IDFT.

(i) Determine the N-point DFT X(k) of the N point sequences given by $x_1(n) = sin(2\pi n/N)$

(ii) Find the 8-point DFT of a real sequence $x(n) = \{1,2,2,2,1,0,0,0,0\}$ using Decimation in frequency algorithm?

(iii) Find out the number of complex multiplications require to perform 1024-point DFT using (a) direct computation and (b) using radix 2 FFT algorithm?

CO3: Design FIR filters and IIR filters for the given specifications

(i) Design a linear phase Low pass FIR filter with order $N = 11$ and cut-off frequency $\pi/6$ .Use a Hanning Window.

(ii) Design a low pass digital butter-worth filter using bilinear transformation for the given specifications. Passband ripple ≤1dB, Passband edge: 4kHz, Stopband Attenuation: ≥40 dB, Stopband edge: 6kHz, Sampling frequency: 24 kHz

CO4: Realize the various FIR and IIR filter structures for given the system function.

(i) Obtain the direct form-I and direct form-II of the transfer function given below.

H(z)= (0.44 z2+ 0.362 z +0.02)/((z2+ 0.8z +.0.5)(z -0.4))

(ii) Realize an FIR system with the given difference equation,

$y(n) = x(n) - 0.5x(n-1) + 0.25x(n-2) + 0.5x(n-3) - 0.4x(n-4) + 0.2x(n-5)$

CO5: Explain the architecture of DSP processor TMS320C67xx and the finite word length effects

(i) Derive the variance of quantization noise in an ADC with step size A, assuming uniformly distributed quantization noise with zero mean?

(ii) Bring out the architectural features of TMS320C67xx digital signal processor?

Module-1

Introduction to Signals & Systems: Continuous and Discrete Time Signals, Generation of Discrete Time Signals – Sampling, Elementary Discrete Time Signals. Classification of signals- Periodic and Non-Periodic Signals, Energy and Power Signals, Even and odd signals. Operations on Discrete Time Signals- Shifting, Folding, Scaling.

Discrete Time Systems-Properties of Discrete Time Systems-Linearity, Time invariance, Causality, Stability. Linear Time Invariant (LTI) Systems – Convolution sum, Impulse response. Difference Equation representation of LTI Systems.

Z-transform-Properties of Z-transform, Inverse Z-transform, System Transfer function.

Module-2

Frequency Domain Representation of Discrete-Time Signals: Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT)-Properties. Relationship between DTFT and DFT

Efficient Computation of DFT: Fast Fourier Transform (FFT) Algorithms-Radix-2 Decimation in Time (DIT) and Decimation in Frequency (DIF) FFT Algorithms, IDFT computation using Radix-2 FFT Algorithms

Module-3

Design of Digital Filters: Classification of Digital filters: FIR Filter , IIR Filter. Types of filters-LPF, HPF, BPF, BSF

Design of FIR Filters: Linear Phase FIR filters-Symmetric and Anti-symmetric FIR Filters, Gibbs Phenomenon, Design of linear phase FIR filters using Window method (Rectangular, Hamming and Hanning).

Design of IIR Digital Filters: Analog Filters (Butterworth), Analog Butterworth Prototype LPF filter design, IIR Filter Design using Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog and Digital Domain. (LPF and HPF only)

Module-4

Realization of Digital Filters: Structures for the realization of Discrete Time Systems: Block diagram and signal flow graph representations of filters.

FIR Filter Structures: Linear Phase realization, Direct Form, Cascade Form.

IIR Filter Structures: Direct Form, Cascade Form and Parallel Form.

Module-5

Hardware architecture for signal processing: Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram and Description.

Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating-point DSP arithmetic, ADC quantization noise, Round-off error

Finite word length effects in IIR digital filters: coefficient quantization errors.

Text Books

1. Proakis J. G. and Manolakis D. G., Digital Signal Processing, 4/e, Pearson Education, 2007.
2. Alan V Oppenheim, Ronald W. Schafer , Discrete-Time Signal Processing, 3rd Edition, Pearson, 2014.
3. Mitra S. K., Digital Signal Processing: A Computer Based Approach, 4/e McGraw Hill (India) 2014

Reference Books

4. Ifeachor E.C. and Jervis B. W., Digital Signal Processing: A Practical Approach, 2/e Pearson Education, 2009.
5. Lyons, Richard G., Understanding Digital Signal Processing, 3/e. Pearson Education India, 2004.
6. Salivahanan S, Digital Signal Processing,4e, Mc Graw —Hill Education New Delhi, 2019

7. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13. John Wiley & Sons, 2003.
8. Vinay.K. Ing1e, John.G.Proakis, Digital Signal Processing: Bookware Companion Series,Thomson,2004
9. Chen, C.T., "Digital Signal Processing: Spectral Computation & Filter Design", Oxford Univ. Press, 2001.

Course Contents and Lecture Schedule

No.	Topic	No. of Lecture Hours
	Module-1	**10 hrs**
1.1	Introduction to Signals & Systems:- Continuous and Discrete Time Signals, Generation of Discrete Time Signals – Sampling	1
1.2	Elementary Discrete Time Signals. Classification of signals	1
1.3	Periodic and Non-Periodic Signals, Energy and Power Signals, Even and odd signals.	1
1.4	Operations on Discrete Time Signals- Shifting, Folding, Scaling.	1
1.5	Discrete Time Systems-Properties of Discrete Time Systems-Linearity,	1
1.6	Time invariance, Causality, Stability.	1
1.7	Linear Time Invariant (LTI) Systems – Convolution sum, Impulse response.	1
1.8	Difference Equation representation of LTI Systems	1
1.9	Z-transform-Properties of Z-transform	1
1.10	Inverse Z-transform, System Transfer function	1
	Module-2	**8 hrs**
2.1	Frequency Domain Representation of Discrete Time Signals: Discrete Time Fourier Transform (DTFT)	1
2.2	Discrete Fourier Transform (DFT)-Properties	1
2.3	Discrete Fourier Transform (DFT)-Properties	1
2.4	Relationship between DTFT and DFT	1
2.5	Efficient Computation of D FT: Fast Fourier Transform (FFT) Algorithms	1
2.6	Radix-2 Decimation in Time (DIT)	1
2.7	Decimation in Frequency (DIF) FFT Algorithms	1
2.8	IDFT computation using Radix-2 FFT Algorithms	1
	Module-3	**10 hrs**
3.1	Design of Digital Filters: Classification of Digital filters: FIR Filter, IIR Filter. Types of filters-LPF, HPF, BPF, BSF	1
3.2	Design of FIR Filters: Linear Phase FIR filters	1
3.3	Symmetric and Anti-symmetric FIR Filters.	1
3.4	Design of linear phase FIR filters using Window method (Rectangular, Hamming and Hanning).	1
3.5	Design of IIR Digital Filters: Analog Filters (Butterworth),	1

3.6	Analog Butterworth Prototype LPF filter design	1
3.7	IIR Filter Design by Impulse Invariance, and Bilinear Transformation	1
3.8	IIR Filter Design by Impulse Invariance, and Bilinear Transformation	1
3.9	Frequency Transformations in the Analog and Digital Domain. (LPF and HPF only)	1
3.10	Frequency Transformations in the Analog and Digital Domain. (LPF and HPF only)	1
	Module-4	**8 hrs**
4.1	Realization of Digital Filters: Structures for the realization of Discrete Time Systems	1
4.2	Block diagram and signal flow graph representations of filters.	1
4.3	FIR Filter Structures: Linear Phase realization	1
4.4	Direct Form,	1
4.5	Cascade Form	1
4.6	IIR Filter Structures: Direct Form,	1
4.7	Cascade Form and Parallel Form	1
4.8	Cascade Form and Parallel Form	1
	Module-5	**6 hrs**
5.1	Hardware architecture for signal processing: Harvard Architecture, pipelining, MAC	1
5.2	Introduction to TMS320C67xx digital signal processor, Functional Block Diagram and Description.	1
5.3	Finite word length effects in DSP systems: Introduction (analysis not required)	1
5.4	Fixed-point and floating-point DSP arithmetic,	1
5.5	ADC quantization noise, Round-off error	1
5.6	Finite word length effects in IIR digital filters: coefficient quantization errors	1

Simulation Assignments

The following simulations to be done in Scilab/ Matlab/ Python/GNU Octave:

1. Plot the elementary discrete time signals
2. Compute the output of an LTI system using Linear Convolution assuming

   $x(n) = \{1, 2, -1, 2\} \quad h(n) = \{1,2,1\}$

3. Consider a signal given by $x(n) = \{1,1,1,1\}$.

   i. Compute the DTFT of the given sequence and plot its magnitude and phase

   ii. Compute the 4 point DFT of the above signal and plot its magnitude and phase

   iii. Compare the above plots and obtain the relationship?

4. Zero pad the sequence x(n) by 4 and compute the 8-point DFT and find the corresponding magnitude and phase plots. Compare the spectra with that in (b) and comment on it.
5. The first five values of the 8 point DFT of a real valued sequence x(n) are given by {0.25, 0.125-j0.3, 0, 0.125-j0.06, 0.5}. Determine the DFT of each of the following sequences using properties. Hint :IDFT may not be computed. $i.\, x_1(n) = x((2-n))_8$ ii. $x_2(n) = x^2(n)$ iii. $x_3(n) = x(n)e^{-j\pi n4/N}$
6. A filter is described by the following difference equation

$$16y(n) + 12y(n-1) + 2y(n-2) - 4y(n-3) - y(n-4)]$$
$$= x(n) - 3x(n-1) + 11x(n-2) - 27x(n-3) + 18x(n-4)$$

i. Determine the Direct form filter structure

ii. Using the Direct form structure, obtain the cascade form filter structure

7. Simulate the following FIR filter and obtain the frequency response

$$H_d(\omega) = 1 \; for \; \frac{\pi}{4} \leq |\omega| \leq \pi$$
$$0 \; for \; |\omega| \leq \frac{\pi}{4}$$

Find the value of h(n) for N=11 and plot frequency response

Model Question Paper

A P J Abdul Kalam Technological University

Fifth Semester B Tech Degree Examination

Branch: Electronics and Computer Science Engineering

Course: ERT 301 DIGITAL SIGNAL PROCESSING

Time: 3 Hrs Max. Marks: 100

PART A

Answer All Questions. Each question carry 3 marks

1. Describe and sketch any three standard discrete time signals. (3) K1
2. Define Z-Transform. Compute the Z-Transform of $x(n) = u(n)$ (3) K2
3. Determine the frequency response of the LTI system given by the difference equation,
   $y(n) = 0.15x(n) + 0.25x(n-1) + x(n-3)$. (3) K2
4. Illustrate the basic butterfly computation used in decimation in time radix-2 FFT algorithm? (3) K1
5. Explain Gibbs phenomenon.
6. Compare and Contrast IIR and FIR filters. (3) K2
7. Obtain the realization with minimum number of multipliers.

$$H(z) = \frac{1}{2} + \frac{1}{4} z^{-1} + \frac{1}{4} z^{-2} + \frac{1}{2} z^{-3}$$ (3) K3

8. Obtain the cascade-form realization of the third order IIR filter transfer function given by
   H(z)= ($0.44 z^2 + 0.362 z + 0.02)/((z^2 + 0.8z + .0.5)(z - 0.4))$ (3) K3
9. Differentiate between Harvard architecture and Von-Nuemann Architecture used in processors? (3) K2
10. Describe round-off error (3) K2

PART-B

Answer any one Question from each module. Each question carries 14 Marks

11. a) Find the convolution of the following sequences using matrix multiplication method (4) K2

$$x(n) = \{1, -2, 3, 1\} \quad y(n) = \{2, -3, -2\}$$

b) Find the Z-transform and plot ROC of the $x(n) = a^n u(n)$ (4) K2

c) State and prove any four properties of Z transform (6) K2

OR

12. a) Define energy and power signals. Give an example for each category. (3) K2

b) A system has input - output relation given by $y(n) = nx(n)$. Determine whether the system is memoryless, causal, linear, time invariant or stable (6) K2

c) State sampling theorem? A signal is given by $x(t) = 2cos(400\pi t) + 4\cos(640\pi t)$. Determine the Nyquist sampling rate (5) K2

13. a.) The first eight points of 14-point DFT of a real valued sequence are

{12, -1+j3, 3+j4, 1-j5, -2+j2, 6+j3, -2-j3, 10}

i) Determine the remaining points

ii) Evaluate x[0] without computing the IDFT of X(k)? (4) K2

b) Compute the 4-point DFT of the sequence x(n) = {0, 2, 4, 6} using Matrix method (6) K2

c) Obtain the relation ship between DFT and Z- Transform (4) K2

OR

14. a) Explain the following properties of DFT i) Linearity ii) Complex conjugate property iii) Time Reversal (5) K2

b) Compute the 8 point DFT of x(n) = (2,1,-1,3,5,2,4,1} using radix-2 decimation in time FFT algorithm. (9) K2

15. a. Design an ideal FIR high pass filter with frequency response

$$H_d(\omega) = 1 \; for \; \frac{\pi}{4} \le |\omega| \le \pi$$

$$0 \; for \; |\omega| \le \frac{\pi}{4}$$

Find the value of h(n) for N=11 (8) K3

b. Write short note on Hamming Window and Hanning Window (6) K2

OR

16. a. Design a digital Butterworth low pass filter with $\omega_p = \pi/6$ $\omega_s = \pi/4$, minimum pass band gain = -2 dB and minimum stop band attenuation = 8 dB. Use bilinear transformation. (Take T = 1 second) (10) K3

b. What is warping effect in bilinear transformation and how it can be eliminated? (4) K2

17. a) Derive and draw the direct form-I, direct form-II and cascade form realization of the given filter, whose difference equation is given as

$$y(n) = 0.1\, y(n-1) + 0.2\, y(n-2) + 3\, x(n) + 3.6\, x(n-1) + 0.6\, x(n-2)$$ (9) K3

b) Draw the direct form II Structure of the system given by the difference equation

$y(n) = 05.\, y(n-1) - 0.25y(n-2) + x(n) + x(n-1)$. (5) K3

OR

18.a) A filter is described by the following difference equation

$$16y(n) + 12y(n-1) + 2y(n-2) - 4y(n-3) - y(n-4)]$$
$$= x(n) - 3x(n-1) + 11x(n-2) - 27x(n-3) + 18x(n-4$$

i. Determine the Direct form filter structure

ii. Using the Direct form structure, obtain the cascade form filter structure (10) K3

b) Obtain the cascade realization of the system function

$$H(z) = 1 + \frac{5}{2} z^{-1} + 2z^{-2} + 2z^{-3}$$ (4) K3

19. a. With the help of a functional block diagram, explain the architecture of TMS320C67xx DSP processor? (10) K2

b. Describe ADC quantization noise (4) K2

OR

20. a) Explain how to minimize the effect of finite word length in IIR digital filters? (7) K2

b) Explain the roundoff error (4) K2

c) Express the fraction 7/8 and -7/8 in sign magnitude, 2's complement and 1's complement form (3) K2

CST 303	COMPUTER NETWORKS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble: Study of this course provides the learners a clear understanding of how computer networks from local area networks to the massive and global Internet are built, how they allow computers to share information and communicate with one another. This course covers the physical aspects of computer networks, layers of OSI Reference model, and inter-networking. The course helps the learners to compare and analyze the existing network technologies and choose a suitable network design for a given system.

Prerequisite: Nil

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

CO#	Course Outcomes
CO1	Explain the features of computer networks, protocols, and network design models **(Cognitive Knowledge: Understand)**
CO2	Describe the fundamental characteristics of the physical layer and identify the usage in network communication **(Cognitive Knowledge: Apply)**
CO3	Explain the design issues of data link layer, link layer protocols, bridges and switches **(Cognitive Knowledge: Understand)**
CO4	Illustrate wired LAN protocols (IEEE 802.3) and wireless LAN protocols (IEEE 802.11) **(Cognitive Knowledge: Understand)**
CO5	Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network **(Cognitive Knowledge: Apply)**
CO6	Illustrate the functions and protocols of the network layer, transport layer, and application layer in inter-networking **(Cognitive Knowledge: Understand)**

Mapping of course outcomes with program outcomes

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

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 teamwork
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	40	30	30

Understand	**50**	**50**	**50**
Apply	**10**	**20**	**20**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**
Continuous Assessment Test : **25 marks**
Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus. The second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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 a student should answer anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction and Physical Layer)

Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models.

Physical Layer – Modes of communication, Physical topologies, Signal encoding, Repeaters and hub, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product.

Module - 2 (Data Link Layer)

Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control(HDLC)protocol. Medium Access Control (MAC) sublayer –Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11, Bridges & switches - Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.

Module - 3 (Network Layer)

Network layer design issues. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast routing, Routing for mobile hosts. Congestion control algorithms. Quality of Service (QoS) - requirements, Techniques for achieving good QoS.

Module - 4 (Network Layer in the Internet)

IP protocol, IP addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First(OSPF) Protocol, Border Gateway Protocol (BGP), Internet multicasting, IPv6, ICMPv6.

Module – 5 (Transport Layer and Application Layer)

Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, TCP segment header, Connection establishment &release, Connection management modeling, TCP retransmission policy, TCP congestion control.

Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME), Simple Network Management Protocol

(SNMP), World Wide Web(WWW) – Architectural overview.

Text Books

1. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).
2. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill

Reference Books

1. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann.
2. Fred Halsall, Computer Networking and the Internet, 5/e.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e.
4. Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998.
5. W. Richard Stevens. TCP/IP Illustrated Volume 1, Addison-Wesley, 2005.
6. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
7. Request for Comments (RFC) Pages - IETF -https://www.ietf.org/rfc.html

Course Level Assessment Questions

Course Outcome1 (CO1)

1. Compare TCP/IP and OSI reference model.
2. The purpose of physical layer is to transport a raw bit stream from one machine to another. Justify.

Course Outcome2 (CO2)

1. Write the physical and transmission characteristics of Optical Fibre Cable guided transmission media.
2. The distance between the sender and receiver systems is about 200 KM. The speed of transmission is 2GB/s. Find out the propagation time?

Course Outcome3 (CO3)

1. Ethernet frames must be at least 64 bytes long to ensure that the transmitter is still going in the event of a collision at the far end of the cable. Fast Ethernet has the same 64-byte minimum frame size but can get the bits out ten times faster. How is it possible to maintain the same minimum frame size?
2. What do you mean by bit stuffing?

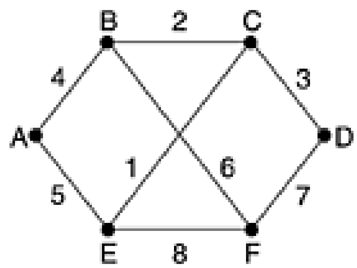
Course Outcome4 (CO4)

1. Draw and explain the frame format for Ethernet.
2. Give the differences between CSMA/CD and CSMA/CA protocol.

Course Outcome5 (CO5)

1. Consider the given subnet in which distance vector routing is used, and the vectors just come in to router C as follows: from B: (5, 0, 8, 12, 6, 2); from D: (16, 12, 6, 0, 9, 10);

and from E: (7, 6, 3, 9, 0, 4). The measured delays from C to B, D, and E, are 6, 3, and 5, respectively. What is C's new routing table? Give both the outgoing line to use and the expected delay.



2. Illustrate the leaky bucket congestion control technique.

Course Outcome 6 (CO6)

1. How do you subnet the Class C IP Address 206.16.2.0 so as to have 30 subnets. What is the subnet mask for the maximum number of hosts? How many hosts can each subnet have?
2. Give the architecture of World Wide Web.

Model Question Paper

QP CODE: ___ **PAGES:**

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 303

Course Name : Computer Networks

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. What does "negotiation" mean when discussing network protocols in a layered architecture? Give an example.

2. Define simplex, half-duplex, and full-duplex transmission modes. Give one example for each.

3. Data link protocols almost always put the CRC in a trailer rather than in a header. Why?

4. An 8-bit byte with binary value 10101111 is to be encoded using an even-parity Hamming code. What is the binary value after encoding?

5. Illustrate the Count to Infinity problem in routing.

6. Describe two major differences between the warning bit method and the Random Early Detection (RED) method.

7. The Protocol field used in the IPv4 header is not present in the fixed IPv6 header. Why?

8. How many octets does the smallest possible IPv6 (IP version 6) datagram contain?

9. Can Transmission Control Protocol(TCP) be used directly over a network (e. g. an Ethernet) without using IP? Justify your answer.

10. When Web pages are sent out, they are prefixed by MIME headers. Why?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) With a neat diagram, explain Open Systems Interconnection (OSI) Reference Model. **(8)**

    (b) Compare Twisted Pair, Coaxial Cable and Optical Fibre guided transmission media. **(6)**

OR

12. (a) Consider two networks providing reliable connection-oriented service. One of them offers a reliable byte stream and the other offers a reliable message stream. Are they identical? Justify your answer. **(8)**

    (b) Sketch the waveform in Manchester and Differential Manchester Encoding for the bitstream 11000110010. **(6)**

13. (a) A bit stream 10011101 is transmitted using the standard CRC method. The generator polynomial is $x^3 + 1$. Show the actual bit string transmitted. Suppose the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. **(8)**

(b) Explain the working of High-Level Data Link Control (HDLC) protocol. **(6)**

OR

14. (a) Explain the working of IEEE 802.11 MAC sublayer. **(10)**

(b) Distinguish between Bridges and Switches. **(4)**

15. (a) Illustrate Distance Vector Routing algorithm with an example. **(8)**

(b) Explain the characteristics of Routing Information Protocol (RIP). **(6)**

OR

16. (a) A computer on a 6-Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 1 Mbps. It is initially filled to capacity with 8 megabits. How long can the computer transmit at the full 6 Mbps? **(8)**

(b) Explain how routing is performed for mobile hosts. **(6)**

17. (a) Explain the address resolution problem using Address Resolution Protocol (ARP) and Reverse Address Resolution Protocol (RARP)with an example network. **(10)**

(b) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? **(4)**

OR

18. (a) How do you subnet the Class C IP address 195.1.1.0 so as to have 10 subnets with a maximum of 12 hosts in each subnet. **(6)**

(b) Draw IPv6 Datagram format and explain its features. **(8)**

19. (a) Distinguish the header formats of Transmission Control protocol (TCP) and User Datagram Protocol (UDP). **(8)**

(b) Explain the principal Domain Name System (DNS) resource record types for **(6)**

IPv4.

OR

20. (a) What is the role of Simple Mail Transfer Protocol (SMTP) in E- mail? **(6)**

(b) With the help of a basic model, explain the working of World Wide Web (WWW). **(8)**

Teaching Plan

No	Contents	No of Lecture Hrs
	Module – 1 (Introduction and Physical Layer) (10 hrs)	
1.1	Introduction, Uses of computer networks.	1 hour
1.2	Network Hardware, Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WAN), Wireless networks, Home networks, Internetworks.	1 hour
1.3	Network Software, Protocol hierarchies, Design issues for the layers.	1 hour
1.4	Connection-oriented and Connectionless services, Service primitives, Relationship of services to protocols.	1 hour
1.5	Reference models, The OSI reference model.	1 hour
1.6	The TCP/IP reference model, Comparisonof OSI and TCP/IP reference models.	1 hour
1.7	Physical layer, Modes of communication, Simplex, Half-duplex, and Full-duplex, Physical topologies, Mesh, Star, Bus, Ring, Hybrid.	1 hour
1.8	Signal encoding, Manchester, Differential Manchester.	1 hour
1.9	Transmission media overview, Guided media (twisted pair, coaxial and fiber optic media), Unguided/wireless media (radio, microwave, and infrared).	1 hour
1.10	Performance indicators, Bandwidth (in Hertz and in Bits per Seconds),	1 hour

	Throughput, Latency (Delay), Queuing time, Bandwidth-Delay product.	
Module 2 – (Data Link Layer) (10 hrs)		
2.1	Data link layer design issues.	1 hour
2.2	Error detection and correction, Error correcting codes	1 hour
2.3	Error detecting codes.	1 hour
2.4	Sliding window protocols.	1 hour
2.5	High-Level Data Link Control(HDLC) protocol.	1 hour
2.6	Medium Access Control (MAC) sublayer, Channel allocation problem, Multiple access protocols.	1 hour
2.7	Ethernet, Ethernet cabling, Manchester encoding, Ethernet MAC sublayer protocol, Binary Exponential Backoff algorithm.	1 hour
2.8	Ethernet performance, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.2: Logical Link Control.	1 hour
2.9	Wireless LANs, 802.11 protocol stack, Physical layer, MAC Sublayer protocol, Frame structure.	1 hour
2.10	Bridges &switches, Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers, and Gateways.	1 hour
Module 3 - (Network Layer) (8 hrs)		
3.1	Network layer design issues.	1 hour
3.2	Routing algorithms, The Optimality Principle, Shortest path routing, Flooding.	1 hour
3.3	Distance Vector Routing.	1 hour
3.4	Link State Routing.	1 hour
3.5	Multicast routing, Routing for mobile hosts.	1 hour

3.6	General principles of congestion control, Congestion prevention policies, Congestion control in virtual circuit subnets.	1 hour
3.7	Congestion control algorithms, Congestion control in Datagram subnets, Load shedding, Jitter control.	1 hour
3.8	Quality of Service, Requirements, Techniques for achieving good Quality of Service.	1 hour
Module 4 – (Network Layer in the Internet) (9 hrs)		
4.1	Network layer in the Internet, Internet Protocol (IP).	1 hour
4.2	IP Addresses, Subnets, Classless Inter-Domain Routing (CIDR).	1 hour
4.3	IP Addresses, Network Address Translation (NAT).	1 hour
4.4	Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP).	1 hour
4.5	Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP).	1 hour
4.6	Open Shortest Path First (OSPF) protocol.	1 hour
4.7	Border Gateway Protocol (BGP).	1 hour
4.8	Internet multicasting.	1 hour
4.9	IPv6, Header format, Extension headers, Internet Control Message Protocol version 6 (ICMPv6).	1 hour
Module 5 - (Transport Layer and Application Layer) (8 hrs)		
5.1	Transport Service, Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP).	1 hour
5.2	Transmission Control Protocol (TCP), TCP segment header, Connection establishment &release, Connection management modeling.	1 hour
5.3	TCP retransmission policy, TCP congestion control.	1 hour
5.4	Application layer, File Transfer Protocol (FTP).	1 hour

5.5	Domain Name System (DNS).	1 hour
5.6	Electronic Mail, Multipurpose Internet Mail Extension (MIME).	1 hour
5.7	Simple Network Management Protocol (SNMP).	1 hour
5.8	World Wide Web, Architectural overview.	1 hour

ERT305	DATABASE MANAGEMENT SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course provides a clear understanding of fundamental principles of Database Management Systems (DBMS) with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization and Transaction Processing Concepts. The course also gives a glimpse of the alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

Prerequisite: Topics covered under the course Data Structures (CST 201), Exposure to a High-Level Language like C/python.

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

CO1	Summarize and exemplify fundamental nature and characteristics of database systems **(Cognitive Knowledge Level: Understand)**
CO2	Model real word scenarios given as informal descriptions, using Entity Relationship diagrams. **(Cognitive Knowledge Level: Apply**)
CO3	Model and design solutions for efficiently representing and querying data using relational model (**Cognitive Knowledge Level: Analyze**)
CO4	Demonstrate the features of indexing and hashing in database applications **(Cognitive Knowledge Level: Apply**)
CO5	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems **(Cognitive Knowledge Level: Apply**)
CO6	Explain various types of NoSQL databases (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

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

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30

Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1: Introduction & Entity Relationship (ER) Model

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification.

ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.

Module 2: Relational Model

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema

Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

Module 3: SQL DML (Data Manipulation Language), Physical Data Organization

SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types.

Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files.

Module 4: Normalization

Different anomalies in designing a database, the idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.

Module 5: Transactions, Concurrency and Recovery, Recent Topics

Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions.
Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing.

Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB)

Main characteristics of Column - Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB)

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

Reference Books:

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018
3. Web Resource: https://www.w3resource.com/redis/
4. Web Resource: https://www.w3schools.in/category/mongodb/
5. Web Resource: https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource : https://www.tutorialspoint.com/arangodb/index.htm

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. List out any three salient features of database systems, which distinguish it from a file system.
2. Give one example each for logical and physical data independence.

Course Outcome 2(CO2):

1. What facts about the relationships between entities EMPLOYEE and PROJECT are conveyed by the following ER diagram?

2. Design an ER diagram for the following scenario:
   There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team.

Course Outcome 3(CO3):

1.For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any three equivalent relational algebra expressions.
2.Given the FDs $P \rightarrow Q$, $P \rightarrow R$, $QR \rightarrow S$, $Q \rightarrow T$, $QR \rightarrow U$, $PR \rightarrow U$, write the sequence of *Armstrong's Axioms* needed to arrive at the following FDs: (a) $P \rightarrow T$ (b) $PR \rightarrow S$ (c) $QR \rightarrow SU$
3.Consider a relation PLAYER (PLAYER-NO, PLAYER-NAME, PLAYER-POSN, TEAM, TEAM-COLOR, COACH-NO, COACH-NAME, TEAM-CAPTAIN). Assume that PLAYER-NO is the *only* key of the relation and that the following dependencies hold:
TEAM→{TEAM-COLOR, COACH-NO, TEAM-CAPTAIN}COACH-NO→COACH-NAME.
i)Is the relation in 2NF? If not, decompose to 2NF.
ii)Is the relation in 3NF? If not, decompose to 3NF.

4. In the following tables foreign keys have the same name as primary keys except DIRECTED-BY, which refers to the primary key ARTIST-ID. Consider only *single-director* movies.

MOVIES(MOVIE-ID, MNAME, GENRE, LENGTH, DIRECTED-BY)
ARTIST(ARTIST-ID, ANAME)
ACTING(ARTIST-ID, MOVIE-ID)

Write SQL expressions for the following queries:

(a) *Name(s) and director name(s) of movie(s) acted by 'Jenny'.*
(b) *Names of actors who have never acted with 'Rony'*
(c) *Count of movies genre-wise.*
(d) *Name(s) of movies with maximum length.*

Course Outcome 4(CO4):

1. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization, block size of 512 bytes and block pointer size of 5 bytes. Compute the number of block accesses needed for retrieving an employee record based on employee number if (i) No index is used (ii) Multi-level primary index is used.

Course Outcome 5(CO5):

1. Determine if the following schedule is *recoverable*. Is the schedule *cascade-less*? Justify your answer. *r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2*. (*Note: ri(X)/wi(X)* means transaction *Ti* issues read/write on item X; *ci* means transaction *Ti* commits.)
2. Two-phase locking protocol ensures serializability. Justify.

Course Outcome 6(CO6):

1. List out any three salient features of NoSQL databases. Give example of a document in MongoDB.

Model Question paper

QPCODE

Reg No:__________________
Name:____________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 305

Course Name: **Database Management Systems**

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

PART A

Answer all Questions. Each question carries 3 Marks

1 List out any three salient features of a database systems.

2 When is multi-valued composite attribute used in ER modelling?

3 For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any two equivalent relational algebra expressions.

4 Outline the concept of *theta*-join.

5 How is the purpose of *where* clause is different from that of having clause?

6 What is the use of a trigger?

7 When do you say that a relation is not in 1NF?

8 Given the FDs P→Q, P→R, QR→S, Q→T, QR→U, PR→U, write the sequence of Armstrong's Axioms needed to arrive at a. P → T b. PR → S

9 What is meant by the lost update problem?

10 What is meant by check pointing?

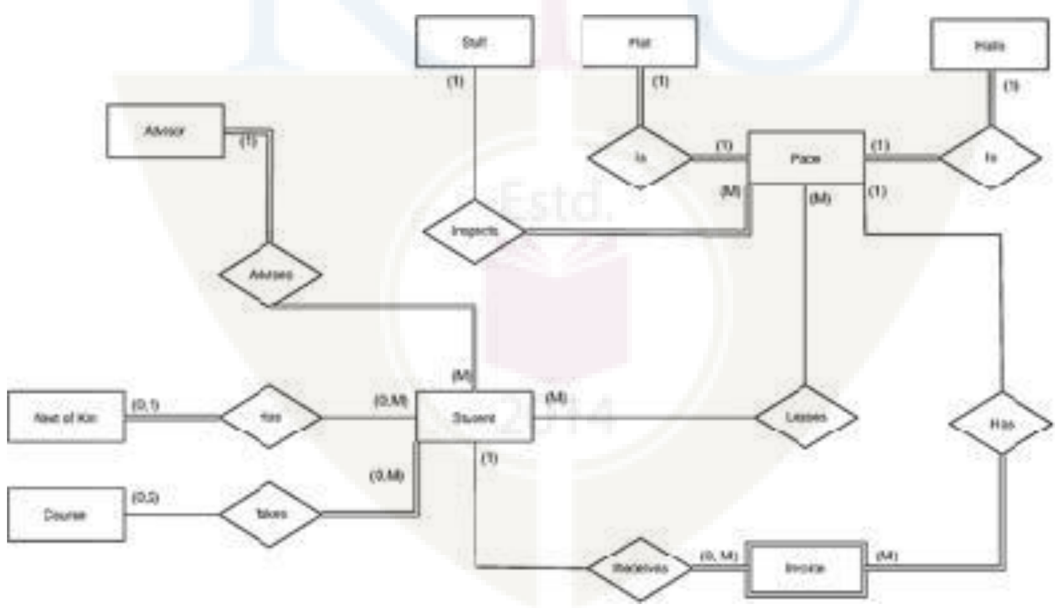
PART B

Answer any one Question from each module. Each question carries 14 Marks

11 a. Design an ER diagram for the following scenario: There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team. For each match we need to keep track of the following: The date on which the game is played The final result of the match. The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card. During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place. Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One referee is the main referee and the other two are assistant referee. (14)

OR

12 a. Interpret the the following ER diagram. (8)



b. Distinguish between physical data independence and logical data independence with suitable examples. (6)

13 EMPLOYEE(<u>ENO</u>, NAME, ADDRESS, DOB, AGE, GENDER, SALARY, DNUM, SUPERENO) (14)

DEPARTMENT(<u>DNO</u>, DNAME, DLOCATION, DPHONE, MGRENO)

PROJECT(<u>PNO</u>, PNAME, PLOCATION, PCOST, CDNO)

DNUM is a foreign key that identifies the department to which an employeebelongs. MGRENO is a foreign key identifying the employee who manages the department. CDNO is a foreign key identifying the department that controls the project. SUPERENO is a foreign key identifying the supervisor of each employee.

Write relational algebra expressions for the following queries:-

(a) Names of female employees whose salary is more than 20000.
(b) Salaries of employee from ‘Accounts’ department
(c) Names of employees along with his/her supervisor's name
(d) For each employee return name of the employee along with his department name and the names of projects in which he/she works
(e) Names of employees working in all the departments

OR

14 a. Write SQL DDL statements for the following (Assume suitable domain types): (10)

i. Create the tables STUDENT(<u>ROLLNO</u>, NAME, CLASS, SEM, ADVISER), FACULTY(<u>FID</u>, NAME, SALARY, DEPT). Assume that ADVISER is a foreign key referring FACUTY table.

ii. Delete department with name ‘CS’ and all employees of the department.

iii. Increment salary of every faculty by 10%.

b. Illustrate foreign key constraint with a typical example. (4)

15 For the relation schema below, give an expression in SQL for each of the queries that follows: (14)

employee(employee-name, street, city)
works(employee-name, company-name, salary)
company(company-name, city)
manages(employee-name, manager-name)

a) Find the names, street address, and cities of residence for all employees who work for the Company 'RIL Inc.' and earn more than $10,000.
b) Find the names of all employees who live in the same cities as the companies for which they work.
c) Find the names of all employees who do not work for 'KYS Inc.'. Assume that all people work for exactly one company.
d) Find the names of all employees who earn more than every employee of 'SB Corporation'. Assume that all people work for at most one company.
e) List out number of employees company-wise in the decreasing order of number of employees.

OR

16 a. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization and block size of 512 bytes compute the number of block accesses needed for selecting records based on employee number if, (9)

i. No index is used
ii. Single level primary index is used
iii. Multi-level primary index is used

Assume a block pointer size of 6 bytes.

b. Illustrate correlated and non-correlated nested queries with real examples. (5)

17 a.Illstrate3NF and BCNF with suitable real examples. (6)

b. Given a relation R(A1,A2,A3,A4,A5) with functional dependencies A1→A2A4 and A4→A5, check if the decomposition R1(A1,A2,A3), R2(A1,A4), R3(A2,A4,A5) is lossless. (8)

OR

18 a. Consider the un-normalized relation R(A, B, C, D, E, F, G) with the FDs A→B , AC→G, AD→EF, EF→G, CDE→AB. Trace the normalization process to reach 3NF relations. (7)

b. Illustrate Lossless Join Decomposition and Dependency Preserving Decomposition with typical examples. (7)

19 a. Discuss the four ACID properties and their importance. (7)

b. Determine if the following schedule is conflict serializable. Is the schedule recoverable? Is the schedule cascade-less? Justify your answers. (7)

r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2

(Note: ri(X)/wi(X) means transaction Ti issues read/write on item X; ci means transaction Ti commits.)

OR

20 a. Discuss the main characteristics of Key-value DB and Graph DB. (7)

b. Illustrate two-phase locking with a schedule containing three transactions. Argue that 2PL ensures serializability. Also argue that 2Pl can lead to deadlock. (7)

Teaching Plan

	Course Name	Hours (48)
	Module 1: Introduction & ER Model	**8**
1.1	Concept & Overview of DBMS, Characteristics of DB system, Database Users.	1
1.2	Structured, semi-structured and unstructured data. Data Models and Schema	1
1.3	Three-Schema-architecture. Database Languages	1
1.4	Database architectures and classification	1
1.5	ER model: basic concepts, entity set & attributes, notations	1
1.6	Relationships and constraints – cardinality, participation, notations	1
1.7	Weak entities, relationships of degree 3	1
1.8	ER diagram – exercises	1
	Module 2: Relational Model	**7**
2.1	Structure of relational Databases, Integrity Constraints	1
2.2	Synthesizing ER diagram to relational schema, Introduction to relational algebra.	1
2.3	Relational algebra: select, project, Cartesian product operations	1
2.4	Relational Algebra: join - Equi-join, Natural join	1
2.5	Query examples	1
2.6	Introduction to SQL, important data types	1
2.7	DDL, Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE	1
	Module 3: SQL DML, Physical Data Organization	**11**
3.1	SQL DML, SQL queries on single and multiple tables	1
3.2	Nested queries (correlated and non-correlated)	1
3.3	Aggregation and grouping	1

	Course Name	Hours (48)
3.4	Views, assertions (with examples)	1
3.5	Triggers (with examples), SQL data types	1
3.6	Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing	1
3.7	Singe level indices, numerical examples	1
3.8	Multi-level-indices, numerical examples	1
3.9	B-Trees and B+Trees (structure only, algorithms not required)	1
3.10	Extendible Hashing	1
3.11	Indexing on multiple keys – grid files	1
	Module 4: Normalization	**8**
4.1	Different anomalies in designing a database, The idea of normalization	1
4.2	Functional dependency, Armstrong's Axioms (proofs not required)	1
4.3	Closures and their computation, Equivalence of FDs, minimal Cover (proofs not required).	1
4.4	1NF, 2NF	1
4.5	3NF, BCNF	1
4.6	Lossless join and dependency preserving decomposition	1
4.7	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 1)	1
4.8	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 2)	1
	Module 5: Transactions, Concurrency and Recovery, Recent Topics	**14**
5.1	Transaction Processing Concepts: Transaction Model	1
5.2	Overview of concurrency control, Significance of concurrency Control & Recovery	1
5.3	Transaction States, System Log	1

	Course Name	Hours (48)
5.4	Desirable Properties of transactions, Serial schedules	1
5.5	Concurrent and Serializable Schedules	1
5.6	Conflict equivalence and conflict serializability	1
5.7	Recoverable and cascade-less schedules	1
5.8	Locking, Two-phase locking, strict 2PL.	1
5.9	Log-based recovery	1
5.10	Deferred database modification (serial schedule), example	1
5.11	Deferred database modification (concurrent schedule) example, check-pointing	1
5.12	Introduction to NoSQL Databases	1
5.13	Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB) [detailed study not expected]	1
5.14	Main characteristics of Column-Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB) [detailed study not expected]	1

ERT307	MICROPROCESSORS AND ADVANCED MICROCONTROLLERS	Category	L	T	P	Credit
		PCC	3	1	0	4

Preamble: The course enables the learners capable of understanding the fundamental architecture of microprocessors and micro controllers. This course focuses on the architecture, assembly language programming, interrupt handling and its programming. It helps the learners to extend the study of latest processors and develop hardware-based solutions.

Prerequisite: Sound knowledge in Digital System Design and Computer organization & architecture.

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

CO#	Course Outcomes
CO1	Illustrate the **architecture**, modes of operation and addressing modes of microprocessors **(Cognitive knowledge: Understand)**
CO2	Develop 8086 **assembly** language programs. **(Cognitive Knowledge Level: Apply**)
CO3	Demonstrate **interrupts**, its handling and programming in 8086. **(Cognitive KnowledgeLevel: Apply**)
CO4	Outline features of **microcontrollers** and develop low level programs. **(Cognitive Knowledge Level: Understand)**
CO5	Describe the building blocks of RISC processors and ARM microcontrollers. **(CognitiveKnowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓	✓								✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	**20**	**20**	**20**
Understand	**40**	**40**	**40**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	:	**10 marks**
Continuous Assessment Tests	:	**25 marks**
Continuous Assessment Assignment	:	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Evolution of microprocessors

8085 microprocessor (Basic Architecture only). 8086 microprocessor – Architecture and signals, Physical Memory organization, Minimum and maximum mode of 8086 system and timings. Comparison of 8086 and 8088.Machine language Instruction format.

Module-2: Addressing modes and instructions

Addressing Modes of 8086. Instruction set – data copy /transfer instructions, arithmetic instructions, logical instructions, string manipulation instructions, branch instructions, unconditional and conditional branch instruction, flag manipulation and processor control instructions. Assembler Directives and operators. Assembly Language Programming with 8086.

Module- 3: Stack and interrupts

Stack structure of 8086, programming using stack- Interrupts - Types of Interrupts and

Interrupt Service Routine- Handling Interrupts in 8086- Interrupt programming. -Programmable Interrupt Controller - 8259, Architecture (Just mention the control word, no need to memorize the control word)- Interfacing Memory with 8086.

Module- 4: Microcontrollers

8051 Architecture- Register Organization- Memory and I/O addressing- Interrupts and Stack- 8051 Addressing Modes- Instruction Set- data transfer instructions, arithmetic instructions, logical instructions, Boolean instructions, control transfer instructions- Simple programs.

Module- 5: ARM Based System

ARM processor fundamentals – Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions, Architecture Revisions.

Introduction to ARM family, ARM7 register architecture, ARM programmer's model. Raspberry pi 4 board - Introduction and brief description.

Text Books

1. Bhurchandi and Ray, Advanced Microprocessors and Peripherals, Third Edition McGraw Hill, 2012.
2. Raj kamal, microcontrollers: architecture, programming, interfacing and system design, Second Edition,2011, Pearson education.
3. Ramesh Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Sixth Edition, 2013, Penram International Publishing Pvt. Ltd.
4. ARM System - on-chip Architecture, Steve Furber, Second Edition, 2001, Pearson Education.
5. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's guide", Morgan Kaufman,2004.

Reference Books

1. Barry B. Brey, The Intel Microprocessors – Architecture, Programming and Interfacing, Eighth Edition, 2008, Pearson Education.
2. A. NagoorKani, Microprocessors and Microcontrollers, Second Edition, 2012, TataMcGraw Hill.

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1) Describe how pipelining is implemented in 8086 microprocessor
2) Illustrate maximum mode signals in 8086.

Course Outcome 2(CO2):

1) Write an 8086 assembly language program for sorting a sequence of N, 8 bit numbers. Describe the modifications that can be done on the above program so that it will sort N, 16 bit numbers. Rewrite the program with those modifications also.

Course Outcome 3 (CO3):

1) Design an interface between 8086 CPU and two chips of 16 x 8 EPROM and

two chips of 32K x 8 RAM. Select the starting address of EPROM suitably. The RAM address must start at 00000H.

2) Give the sequence of instructions for setting the IVT for interrupt type 23H. Assume the Interrupt Service Routine, is present in the code segment named CODE.

3) Describe the role of Interrupt Request register and In service register in 8259.

Course Outcome 4(CO4):

1) Write an 8051 assembly language program to count the number of 1's and 0's in a given 8 bit number

2) Write an 8051 assembly language program for computing the square root of an 8 bit number.

Course Outcome 5(CO5):

1) Differentiate between ARM9 five stage pipeline and ARM10 six stage pipeline.
2) What are the different features of ARM instruction set that make it suitable for embedded applications.

Model Question Paper

QP CODE:

Reg No: _______________

Name:__________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 307

Course Name: Microprocessors and Advanced Microcontrollers

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

PART A

Answer All Questions. Each Question Carries 3 Marks **(10x3=30)**

1. Describe the functions of following signals in 8086
   a)NMI b)ALE
2. List any three differences between 8085 and 8086 microprocessors.
3. Assume AL register is having the value 7FH. What will be the content of AL after the following instructions are executed
   a)ROR AL,01 b)SAR AL,01
4. Specify the use of following assembler directives - EQU, EVEN
5. Differentiate between maskable and non maskable interrupts?
6. Define Interrupt Service Routine? How to find the address of the ISR corresponding to a given interrupt in 8086?
7. Differentiate between indirect and indexed addressing modes in 8051.
8. Write the sequence of 8051 instructions to store any two numbers at twoconsecutive locations 70H and 71H, multiply them and store the result in location 72H.
9. Give 5 features of ARM processors.
10. What is current program status register.

PART B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Specify the significance of segmentation and how it is implemented in 8086 **(5)**

(b) Explain the maximum mode signals in 8086. **(9)**

OR

12. (a) Write down the differences between 8086 and 8088 processors **(4)**

(b) Explain the physical memory organization of 8086 with a neat diagram. How does the 8086 processor access a word from an odd memory location? How many memory cycles does it take? **(10)**

13. (a) Write an 8086-assembly language program for finding the sum of the squares of first N natural numbers. Calculate the squares of each number using a subroutine SQUARE. **(10)**

(b) Describe any four control transfer instructions in 8086. **(4)**

OR

14. (a) Write an 8086 assembly language program for printing the reverse of a given input string. **(5)**

(b) Explain the addressing modes for sequential control flow instructions in 8086. **(9)**

15. (a) Give the stack structure of 8086. **(5)**

(b) Explain the architecture of 8259 with diagram **(9)**

OR

16. (a) Interface 32Kx8 RAM using four numbers of 8Kx8 memory chips and 16Kx8 ROM using two numbers of 8Kx8 EPROM chips. The address map is given as RAM starts at 00000H and ROM ends at FFFFFH **(10)**

(b) Describe the predefined interrupts in 8086 **(4)**

17. Explain the architecture of 8051 microcontroller. **(9)**

(b) Write an 8051-assembly language program for adding two matrices whose elements are stored sequentially in some memory location. Assume suitable locations. **(5)**

OR

18. (a) Explain the internal data memory organization of 8051. **(9)**

(b)Describe the control transfer instructions of 8051 microcontroller. **(5)**

19. (a) Draw the ARM-7 register architecture and explain**.** **(7)**

(b)Draw and explain the programming model of an ARM processor. **(7)**

OR

20. Draw the architectural block diagram of ARM and explain data flow referring each unit. **(14)**

Teaching Plan

No	Contents	Hours (45)
	Module 1 : (Evolution of microprocessors) (9 hours)	
1.1	Overview of 8085 microprocessor	1 hour
1.2	Architecture of8085	1 hour
1.3	Architecture of 8086	1hour
1.4	Signals in 8086	1hour
1.5	Physical Memory organization	1hour
1.6	Minimum and maximum mode 8086 system and timings (Lecture 1)	1hour
1.7	Minimum and maximum mode 8086 system and timings (Lecture 2)	1hour
1.8	Comparison of 8086 and 8088	1hour
1.9	Machine language Instruction format	1hour
	Module 2 :(Programming of 8086) (9 hours)	
2.1	Addressing Modes of 8086	1 hour
2.2	Instruction set – data copy/transfer instructions	1hour
2.3	arithmetic instructions, logical instructions	1hour
2.4	string manipulation instructions, branch instructions	1hour
2.4	unconditional and conditional branch instruction	1hour
2.5	flag manipulation and processor control instructions	1hour
2.6	Assembler Directives and operators	1hour
2.7	Assembly Language Programming with 8086(Lecture 1)	1hour
2.8	Assembly Language Programming with 8086(Lecture 2)	1hour
2.9	Assembly Language Programming with 8086(Lecture 3)	1hour
	Module 3 : (Stack and Interrupts) (9 hours)	
3.1	Stack structure of 8086, programming using stack.	1hour
3.2	Types of Interrupts and Interrupt Service Routine.	1hour
3.3	Handling Interrupts in 8086(Lecture 1)	1hour
3.4	Handling Interrupts in 8086(Lecture 2)	1hour

3.5	Interrupt programming.	1hour
3.6	Programmable Interrupt Controller -8259 (Lecture 1)	1hour
3.7	Programmable Interrupt Controller -8259 (Lecture 2)	1hour
3.8	Interfacing Memory with 8086 (Lecture 1)	1hour
3.9	Interfacing Memory with 8086 (Lecture 2)	1hour
Module 4 :(Interfacing chips) (11 hours)		
4.1	8051 Architecture (Lecture 1)	1hour
4.2	8051 Architecture (Lecture 2)	1hour
4.3	Register Organization, Memory and I/O addressing	1hour
4.4	Interrupts and Stack	1hour
4.5	Addressing Modes	1hour
4.6	Data transfer instructions, Arithmetic instructions	1hour
4.7	Logical instructions,	1hour
4.8	Boolean instructions	1hour
4.9	Control transfer instructions	1hour
4.10	Programming of 8051 (Lecture 1)	1hour
4.11	Programming of 8051(Lecture 2)	1hour
Module 5 : (Microcontrollers) (7 hours)		
5.1	ARM processor fundamentals – Registers	1hour
5.2	Current Program Status Register, Pipeline	1hour
5.3	Exceptions, Interrupts, and the Vector Table	1hour
5.4	Core Extensions, Architecture Revisions.	1hour
5.5	Introduction to ARM family, ARM7 register architecture	1hour
5.6	ARM programmer's model.	1hour
5.7	Raspberry pi 4 board - Introduction and brief description.	1hour

CST 309	MANAGEMENT OF SOFTWARE SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	0	0	3	2019

Preamble: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance, Project Management concepts and technology trends. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite: Basic understanding of Object Oriented Design and Development.

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

CO1	Demonstrate Traditional and Agile Software Development approaches **(Cognitive Knowledge Level: Apply)**
CO2	Prepare Software Requirement Specification and Software Design for a given problem. **(Cognitive Knowledge Level**: **Apply**)
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project. **(Cognitive Knowledge Level: Apply**)
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with a traditional/agile framework**. (Cognitive Knowledge Level: Apply**)
CO5	Utilize SQA practices, Process Improvement techniques and Technology advancements in cloud based software models and containers & microservices. **(Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔		✔						✔
CO2	✔	✔	✔	✔		✔				✔	✔	✔
CO3	✔	✔	✔	✔				✔		✔	✔	✔
CO4	✔	✔	✔	✔		✔			✔	✔	✔	✔
CO5	✔	✔	✔	✔		✔						✔

	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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**50**
Apply	**30**	**30**	**20**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks** (Each student shall identify a software development problem and prepare Requirements Specification, Design Document, Project Plan and Test case documents for the identified problem as the assignment.)

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

Syllabus

Module 1 : Introduction to Software Engineering (7 hours)

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.

Module 2 : Requirement Analysis and Design (8 hours)

Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per “IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”. Case study: The Ariane 5 launcher failure.

Module 3 : Implementation and Testing (9 hours)

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.

Module 4 : Software Project Management (6 hours)

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.

Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service(IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment.

Text Books

1. Book 1 - Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Book 2 - Roger S. Pressman, Software Engineering : A practitioner’s approach, McGraw Hill publication, Eighth edition, 2014
3. Book 3 - Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

References

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements SpeciÞcations
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design—Software Design Descriptions

3. David J. Anderson, Kanban, Blue Hole Press 2010
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
5. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
6. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.
7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
8. Henrico Dolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
9. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
10. StarUML documentation - https://docs.staruml.io/
11. OpenProject documentation - https://docs.openproject.org/
12. BugZilla documentation - https://www.bugzilla.org/docs/
13. GitHub documentation - https://guides.github.com/
14. Jira documentation - https://www.atlassian.com/software/jira

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the advantages of an incremental development model over a waterfall model?
2. Illustrate how the process differs in agile software development and traditional software development with a socially relevant case study. (Assignment question)

Course Outcome 2 (CO2):

1. How to prepare a software requirement specification?
2. Differentiate between Architectural design and Component level design.
3. How does agile approaches help software developers to capture and define the user requirements effectively?
4. What is the relevance of the SRS specification in software development?
5. Prepare a use case diagram for a library management system.

Course Outcome 3 (CO3):

1. Differentiate between the different types of software testing strategies.
2. Justify the need for DevOps practices?
3. How do design patterns help software architects communicate the design of a complex system effectively?

4. What are the proactive approaches one can take to optimise efforts in the testing phase?

Course Outcome 4 (CO4):

1. Illustrate the activities involved in software project management for a socially relevant problem?
2. How do SCRUM, Kanban and Lean methodologies help software project management?
3. Is rolling level planning in software project management beneficial? Justify your answer.
4. How would you assess the risks in your software development project? Explain how you can manage identified risks?

Course Outcome 5 (CO5):

1. Justify the importance of Software Process improvement?
2. Explain the benefits of cloud based software development, containers and microservices.
3. Give the role of retrospectives in improving the software development process.
4. Illustrate the use of project history data as a prediction tool to plan future socially relevant projects.

Model Question Paper

QP CODE:

Reg No:______________

Name :______________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 309

Course Name: Management of Software Systems

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

PART A

Answer all Questions. Each question carries 3 marks

1. Why professional software that is developed for a customer is not simply the programs that have been developed and delivered.
2. Incremental software development could be very effectively used for customers who do not have a clear idea about the systems needed for their operations. Justify.
3. Identify any four types of requirements that may be defined for a software system
4. Describe software architecture
5. Differentiate between GPL and LGPL?
6. Compare white box testing and black box testing.
7. Specify the importance of risk management in software project management?
8. Describe COCOMO cost estimation model.
9. Discuss the software quality dilemma
10. List the levels of the CMMI model? **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Compare waterfall model and spiral model **(8)**

(b) Explain Agile ceremonies and Agile manifesto (6)

12. (a) Illustrate software process activities with an example. (8)

(b) Explain Agile Development techniques and Agile Project Management (6)

13. (a) What are functional and nonfunctional requirements? Imagine that you are developing a library management software for your college, list eight functional requirements and four nonfunctional requirements. (10)

(b) List the components of a software requirement specification? (4)

OR

14. (a) Explain Personas, Scenarios, User stories and Feature identification? (8)

(b) Compare Software Architecture design and Component level design (6)

15. (a) Explain software testing strategies. (8)

(b) Describe the formal and informal review techniques. (6)

OR

16. (a) Explain Continuous Integration, Delivery, and Deployment CI/CD/CD) (8)

(b) Explain test driven development (6)

17. (a) What is a critical path and demonstrate its significance in a project schedule with the help of a sample project schedule. (8)

(b) Explain plan driven development and project scheduling. (6)

OR

18. (a) Explain elements of Software Quality Assurance and SQA Tasks. (6)

(b) What is algorithmic cost modeling? What problems does it suffer from when (8) compared with other approaches to cost estimation?

19. (a) Explain elements of Software Quality Assurance and SQA Tasks. **(8)**

(b) Illustrate SPI process with an example. **(6)**

OR

20. (a) Compare CMMI and ISO 9001:2000. **(8)**

(b) How can Software projects benefit from Container deployment and Micro service deployment? **(6)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module 1 : Introduction to Software Engineering (7 hours)		
1.1	Introduction to Software Engineering.[Book 1, Chapter 1]	1 hour
1.2	Software process models [Book 1 - Chapter 2]	1 hour
1.3	Process activities [Book 1 - Chapter 2]	1 hour
1.4	Coping with change [Book 1 - Chapter 2, Book 2 - Chapter 4]	1 hour
1.5	Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care. [Book 1 - Chapter 1]	1 hour
1.6	Agile software development [Book 1 - Chapter 3]	1 hour
1.7	Agile development techniques, Agile Project Management.[Book 1 - Chapter 3]	1 hour
Module 2 : Requirement Analysis and Design (8 hours)		
2.1	Functional and non-functional requirements, Requirements engineering processes [Book 1 - Chapter 4]	1 hour
2.2	Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix [Book 1 - Chapter 4]	1 hour
2.3	Developing use cases, Software Requirements Specification Template [Book 2 - Chapter 8]	1 hour

2.4	Personas, Scenarios, User stories, Feature identification [Book 3 - Chapter 3]	1 hour
2.5	Design concepts [Book 2 - Chapter 12]	1 hour
2.6	Architectural Design [Book 2 - Chapter 13]	1 hour
2.7	Component level design [Book 2 - Chapter 14]	1 hour
2.8	Design Document Template. Case study: The Ariane 5 launcher failure. [Ref - 2, Book 2 - Chapter 16]	1 hour
	Module 3 : Implementation and Testing (9 hours)	
3.1	Object-oriented design using the UML, Design patterns [Book 1 - Chapter 7]	1 hour
3.2	Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD [Book 1 - Chapter 7]	1 hour
3.3	Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. [Book 2 - Chapter 20]	1 hour
34	Informal Review, Formal Technical Reviews, Post-mortem evaluations. [Book 2 - Chapter 20]	1 hour
3.5	Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing and Debugging (basic concepts only). [Book 2 - Chapter 22]	1 hour
3.6	White box testing, Path testing, Control Structure testing, Black box testing. Test documentation [Book 2 - Chapter 23]	1 hour
3.7	Test automation, Test-driven development, Security testing. [Book 3 - Chapter 9]	1 hour
3.8	DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. [Book 3 - Chapter 10]	1 hour
3.9	Software Evolution - Evolution processes, Software maintenance. [Book 1 - Chapter 9]	1 hour
	Module 4 : Software Project Management (6 hours)	
4.1	Software Project Management - Risk management, Managing people, Teamwork [Book 1 - Chapter 22]	1 hour
4.2	Project Planning - Software pricing, Plan-driven development, Project scheduling, Agile planning [Book 1 - Chapter 23]	1 hour
4.3	Estimation techniques [Book 1 - Chapter 23]	1 hour
4.4	Configuration management [Book 1 - Chapter 25]	1 hour

4.5	Agile software management - SCRUM framework [Book 2 - Chapter 5]	1 hour
4.6	Kanban methodology and lean approaches.[Ref 9 - Chapter 2]	1 hour
Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)		
5.1	Software Quality, Software Quality Dilemma, Achieving Software Quality. [Book 2 - Chapter 19]	1 hour
5.2	Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. [Book 3 - Chapter 21]	1 hour
5.3	Software Process Improvement (SPI), SPI Process [Book 2 - Chapter 37]	1 hour
5.4	CMMI process improvement framework, ISO 9001:2000 for Software. [Book 2 - Chapter 37]	1 hour
5.5	Cloud-based Software - Virtualisation and containers, IaaS, PaaS, SaaS.[Book 3 - Chapter 5]	1 hour
5.6	Microservices Architecture - Microservices, Microservices architecture, Microservice deployment [Book 3 - Chapter 6]	1 hour

ERL331	COMPUTER NETWORKING LAB	CATEGORY	L	T	P	Credit
		PCC	0	0	3	2

Preamble:

The course enables the learners to get hands-on experience in network programming using Linux System calls and network monitoring tools. It covers implementation of network protocols and algorithms, configuration of network services and familiarization of network simulators. This helps the learners to develop, implement protocols and evaluate its performance for real world networks.

Prerequisite: Sound knowledge in Programming in C, Data Structures and Computer Networks

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

CO#	Course Outcomes
CO1	Use network related commands and configuration files in Linux Operating System. **(Cognitive Knowledge Level: Understand).**
CO2	Develop network application programs and protocols. **(Cognitive Knowledge Level: Apply)**
CO3	Analyze network traffic using network monitoring tools. **(Cognitive Knowledge Level: Apply)**
CO4	Design and setup a network and configure different network protocols. **(Cognitive Knowledge Level: Apply)**
CO5	Develop simulation of fundamental network concepts using a network simulator. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓					✓		✓		✓
CO2	✓	✓	✓	✓				✓		✓		✓
CO3	✓	✓	✓	✓	✓			✓		✓		✓

CO4	✔	✔	✔	✔	✔	✔		✔		✔		✔
CO5	✔	✔	✔	✔	✔			✔		✔		✔

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 teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Test (Internal Exam) Marks in percentage**	**End Semester Examination Marks in percentage**
Remember	**20**	**20**
Understand	**20**	**20**
Apply	**60**	**60**
Analyze		
Evaluate		
Create		

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**75**	**75**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	: **15 marks**
Continuous Evaluation in Lab	: **30 marks**
Continuous Assessment Test	: **15 marks**
Viva voce	: **15 marks**

Internal Examination Pattern:

The Internal examination shall be conducted for 100 marks, which will be converted to out of 15, while calculating Internal Evaluation marks. The marks will be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva - 30 marks.

End Semester Examination Pattern:

The End Semester Examination will be conducted for a total of 75 marks and shall be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva- 30 marks.

Operating System to Use in Lab	: Linux
Compiler/Software to Use in Lab	: gcc, NS2
Programming Language to Use in Lab	: Ansi C

Fair Lab Record:

All the students attending the Networking Lab should have a Fair Record. Every experiment conducted in the lab should be noted in the fair record. For every experiment, in the fair record, the right-hand page should contain experiment heading, experiment number, date of experiment, aim of the experiment, procedure/algorithm followed, other such details of the experiment and final result. The left-hand page should contain a print out of the respective code with sample input and corresponding output obtained. All the experiments noted in the fair record should be verified by the faculty regularly. The fair record, properly certified by the faculty, should be produced during the time of End Semester Examination for the verification by the examiners.

Syllabus

*Mandatory

(Note: At least one program from each topic in the syllabus should be completed in the Lab)

1. 1. Getting started with the basics of network configuration files and networking commands in Linux.*
2. To familiarize and understand the use and functioning of system calls used for network programming in Linux.*
3. Implement client-server communication using socket programming and TCP as transport layer protocol*
4. Implement client-server communication using socket programming and UDP as transport layer protocol*
5. Simulate sliding window flow control protocols.* (Stop and Wait, Go back N, Selective Repeat ARQ protocols)
6. Implement and simulate algorithm for Distance Vector Routing protocol or Link State Routing protocol.*
7. Implement Simple Mail Transfer Protocol.
8. Implement File Transfer Protocol.*
9. Understanding the Wireshark tool.*
10. Implement congestion control using a leaky bucket algorithm.*
11. Study of NS2 simulator*
12. Design and configure a network with multiple subnets with wired and wireless LANs using required network devices. Configure commonly used services in the network.

Networking Lab-Practice Questions

1 a) View the configuration, including addresses of your computers network interfaces.

b) Test the network connectivity between your computer and several other computers.

c) View the active TCP connections in the computer after visiting a website.

d) Find the hardware/MAC address of another computer in the network using ARP.

2 Write the system calls used for creating sockets and transferring data between two nodes.

3 a) Implement a multi-user chat server using TCP as transport layer protocol.

b) Implement a simple web proxy server that accepts HTTP requests and forwarding to remote servers and returning data to the client using TCP

4 Implement a Concurrent Time Server application using UDP to execute the programat a remote server. Client sends a time request to the server, server sends its system time back to the client. Client displays the result.

5 a) Implement Stop-and-Wait ARQ flow control protocol.

a. Implement Go-Back--N ARQ flow control protocol.

b. Implement Selective Repeat ARQ flow control protocol.

6 Implement Distance Vector Routing algorithm or Link State Routing algorithm..

7 Implement Simple Mail Transfer Protocol.

8 Develop a concurrent file server which will provide the file requested by a client if it exists. If not, the server sends appropriate message to the client. Server should also send its process ID (PID) to clients for display along with the file or the message.

9 Implement leaky bucket algorithm for congestion control.

10 a) Using Wireshark, Capture packets transferred while browsing a selected website. Investigate the protocols used in each packet, the values of the header fields and the size
of the packet.

a. Using Wireshark, observe three way handshaking connection establishment, three way handshaking connection termination and Data transfer in client server communication using TCP.

b. Explore at least the following features of Wireshark: filters, Flow graphs (TCP), statistics, and protocol hierarchies.

11 Design and configure a network (wired and wireless LANs) with multiple subnets using required network devices. Configure at least three of the following services in the network- TELNET, SSH, FTP server, Web server, File server, DHCP server and DNS server.

12 a) The network consists of TCP source node (n0) and destination node (n1) over an area size of 500m x 500m. Node (n0) uses Agent/TCP/Reno as the sending TCP agent and FTP traffic source. Node (n1) is the receiver of FTP transfers, and it uses Agent/TCP sink as its TCP-agent for the connection establishment. Run the simulation for 150 seconds and show the TCP window size in two static nodes scenario with any dynamic routing protocol. Run the script and analyze the output graph for the given scenario.

b) Simulate the transmission of ping messages over a star network topology consisting of 'n' nodes and find the number of packets dropped due to congestion using NS2simulator.

c) Simulate Link State Protocol or Distance Vector Routing protocol in NS2.

Reference Books:

1. W. Richard Stevens, Bill Fenner, Andy Rudoff, UNIX Network Programming: Volume 1, The Sockets Networking API, 3rd Edition, Pearson, 2015
2. Lisa Bock, Learn Wireshark: Confidently navigate the Wireshark interface and solvereal-world networking problems, Packt Publishing, 2019
3. Teerawat Issariyakul, Ekram Hossain, Introduction to Network Simulator NS2,2ndEdition, Springer,2019

CSL 333	DATABASE MANAGEMENT SYSTEMS LAB	Category	L	T	P	Credits	Year of introduction
		PCC	0	0	4	2	2019

Preamble:

The Database Management Systems course is intended to impart the elementary concepts of a database management system to students and equip them to design and implement a database application based on those concepts. This course helps the learners to get practical exposure on database creation, SQL queries creation, transaction processing and NoSQL & MongoDB based operations. The course enables the students to create, manage and administer the databases, develop necessary tools for the design and development of the databases, and to understand emerging technologies to handle Big Data.

Prerequisite: A sound knowledge of the basics of relational DBMS.

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

CO#	Course Outcomes
CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches. **(Cognitive Knowledge Level: Apply)**
CO2	Construct queries using SQL for database creation, interaction, modification, and updation. **(Cognitive Knowledge Level: Apply)**
C03	Design and implement triggers and cursors. (Cognitive Knowledge Level: **Apply**)
C04	Implement procedures, functions, and control structures using PL/SQL**. (Cognitive Knowledge Level: Apply)**
CO5	Perform CRUD operations in NoSQL Databases. **(Cognitive Knowledge Level: Apply)**
C06	Develop database applications using front-end tools and back-end DBMS. **(Cognitive Knowledge Level: Create)**

Mapping of course outcomes with program outcomes

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

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern:

Bloom's Category	**Continuous Assessment Test (Internal Exam)Percentage**	**End Semester Examination Percentage**
Remember	**20**	**20**
Understand	**20**	**20**
Apply	**60**	**60**
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance : **15 marks**
Continuous Evaluation in Lab : **30 marks**
Continuous Assessment Test : **15 marks**
Viva-voce : **15 marks**

Internal Examination Pattern : The marks will be distributed as Schema/Logic: 30 marks, Program/Queries: 20 marks, Output: 20 marks, and Viva: 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern:
The marks will be distributed as Schema/Logic: 30 marks,
Program/Queries: 20 marks, Output: 20 marks, and Viva: 30 marks. Total 100 marks will be converted out of 75 for the End Semester Examination.

DBMS software: Oracle, MySQL, SQL Server, PostgreSQL, MongoDB.
Front end Tool: Java

Fair Lab Record:
All Students attending the DBMS Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record, the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Schemas/Menu & Form Design, and Query questions. The left hand page should contain Queries and sample output(relations created, Form, and Menu Output) obtained for a set of input.

Syllabus

1. Design a database schema for an application with ER diagram from a problem description **.
2. Creation, modification, configuration, and deletion of databases using UI and SQL Commands **.
3. Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships** (with the ER diagram designed in step 1).

4. Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands)**.
5. Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)**.
6. Implementation of built-in functions in RDBMS**.
7. Implementation of various aggregate functions in SQL**.
8. Implementation of Order By, Group By & Having clause **.
9. Implementation of set operators nested queries, and join queries **.
10. Implementation of queries using temp tables.
11. Practice of SQL TCL commands like Rollback, Commit, Savepoint **.
12. Practice of SQL DCL commands for granting and revoking user privileges **.
13. Practice of SQL commands for creation of views and assertions ** .
14. Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN-ELSIF, CASE, WHILE using PL/SQL **.
15. Creation of Procedures, Triggers and Functions**.
16. Creation of Packages **.
17. Creation of Cursors **.
18. Creation of PL/SQL blocks for exception handling **.
19. Database backup and restore using commands.
20. Query analysis using Query Plan/Show Plan.
21. Familiarization of NoSQL Databases and CRUD operations**.
22. Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables**.

** mandatory

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

References

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018

Practice Questions

Design a normalized database schema for the following requirement.

The requirement: A library wants to maintain the record of books, members, book issue, book return, and fines collected for late returns, in a database. The database can be loaded with book information. Students can register with the library to be a member. Books can be issued to students with a valid library membership. A student can keep an issued book with him/her for a maximum period of two weeks from the date of issue, beyond which a fine will be charged. Fine is calculated based on the delay in days of return. For 0-7 days: Rs 10, For 7 – 30 days: Rs 100, and for days above 30 days: Rs 10 will be charged per day.

Sample Database Design

BOOK (**Book_Id**, Title, Language_Id, MRP, Publisher_Id, Published_Date, Volume, Status) // Language_Id, Publisher_Id are FK (Foreign Key)

AUTHOR(Author_Id, Name, Email, Phone_Number, Status)

BOOK_AUTHOR(Book_Id, Author_Id) // many-to-many relationship, both columns are PKFK (Primary Key and Foreign Key)

PUBLISHER(Publisher_id, Name, Address)

MEMBER(Member_Id, Name, Branch_Code, Roll_Number, Phone_Number, Email_Id, Date_of_Join, Status)

BOOK_ISSUE(Issue_Id, Date_Of_Issue, Book_Id, Member_Id, Expected_Date_Of_Return, Status) // Book+Id and Member_Id are FKs

BOOK_RETURN(Issue_Id, Actual_Date_Of_Return, LateDays, LateFee) // Issue_Id is PK and FK

LANGUAGE(Language_id, Name) //Static Table for storing permanent data

LATE_FEE_RULE(FromDays, ToDays, Amount) // Composite Key

EXERCISES

1. Create a normalized database design with proper tables, columns, column types, and constraints
2. Create an ER diagram for the above database design.
3. Write SQL commands to
   a. Create a database by name *Library*. Drop the database and re-create it.
   b. Create DDL statements and create the tables and constraints (from the design) in the database created in step-a (*Library*)

Notes: [Create a script file and execute it. Create the script file in such a way that,,if the table exists, drop the tables and recreate)]

c. Create and execute DROP TABLE command in tables with and without FOREIGN KEY constraints.
d. Create and execute ALTER TABLE command in tables with data and without data.
e. Create and execute SQL commands to build indices on Member_Id and Book_Id on table Book_Issue.
f. Create and execute GRANT/REVOKE commands on tables.
g. Create and execute SQL commands to insert data into each of the tables designed
h. Learn and execute bulk import of data to tables from CSV files (insert 1000 records of books into the BOOK table from a CSV file).
i. Create and execute UPDATE/DELETE commands on tables. Try to update/delete rows with Primary and Foreign Keys. Try bulk updates or deletes using SQL UPDATE statement

4. Write SQLQuery to retrieve the following information
    a. Get the number of books written by a given author
    b. Get the list of publishers and the number of books published by each publisher
    c. Get the names of authors who jointly wrote more than one book.
    d. Get the list of books that are issued but not returned
    e. Get the list of students who reads only ‘Malayalam’ books
    f. Get the total fine collected for the current month and current quarter
    g. Get the list of students who have overdue (not returned the books even on due date)
    h. Calculate the fine (as of today) to be collected from each overdue book.
    i. Members who joined after Jan 1 2021 but has not taken any books
5. Book return should insert an entry into the Book_Return table and also update the status in Book_Issue table as ‘Returned’. Create a database *TRANSACTION* to do this operation (stored procedure).
6. Create a database view ‘Available_Books’, which will list out books that are currently available in the library
7. Create a database procedure to add, update and delete a book to the Library database (use parameters).
8. Use cursors and create a procedure to print Books Issue Register (page wise – 20 rows in a page)
9. Create a history table (you may use the same structure without any keys) for the MEMBER table and copy the original values of the row being updated to the history table using a TRIGGER.
10. NoSQL Exercise
    a. Practice Mongo DB CRUD operations. Refer: https://docs.mongodb.com/manual/crud/

b. You may use a MongoDB local installation or cloud MongoDB services like MongoDB Atlas for this exercise
c. For documentation: Refer: https://docs.mongodb.com/manual/introduction/

11. Application Development Problem examples:

1) Inventory Control System.
2) Material Requirement Processing.
3) Hospital Management System.
4) Railway Reservation System.
5) Personal Information System.
6) Web Based User Identification System.
7) Timetable Management System.
8) Hotel Management System.

SEMESTER V

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT381	**EMBEDDED SYSTEMS**	VAC	3	1	0	4

Prerequisite: ERT 281 Logic Circuit Design, ERT 282 Microprocessors and Microcontrollers

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

CO 1	Understand the embedded system fundamentals and system Design**(Cognitive Knowledge Level: Understand)**
CO 2	Understand the peripheral devices and their interfacing with the processor. **(Cognitive Knowledge Level: Understand)**
CO 3	Study the ARM processor Architecture, pipeline processor organization and assembly language programming using ARM.**(Cognitive Knowledge Level: Apply)**
CO4	Understand the THUMB instructon set and architectural support for high level languages. **(Cognitive Knowledge Level: Apply)**
CO5	Explain the basics of operating systems, concept of task scheduling and issue related with multitasking. **(Cognitive Knowledge Level: 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	✓	✓	✓		✓			✓				✓
CO 2	✓	✓	✓		✓			✓				✓
CO 3	✓	✓	✓		✓			✓	✓			✓
CO 4	✓	✓	✓		✓			✓				✓
CO 5	✓	✓	✓		✓			✓				✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
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PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
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

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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): **Understand the embedded system fundamentals and system design. (K2)**

1. Give the challenges of embedded computing.
2. Give the structural description of embedded system.
3. What are the phases of EDLC?

Course Outcome 2 (CO2): **Understand the peripheral devices and their interfacing with the processor. (K2)**

1. Compare and contrast the PCI bus and PCI-X bus.
2. How the ROM memories are classified? Explain.
3. How the peripheral devices are connected with processors?

Course Outcome 3 (CO3):Study the ARM processor architecture and pipeline processor organization. (K3)

1. Give the architecture of the ARM processor and explain the registers.
2. Explain the pipelined architecture of ARM processor.
3. Write an ARM assembly language program to print the sum of two numbers.

Course Outcome 4 (CO4): To write programs in assembly and high level languages for ARM processor. (K3)

1. Write a note on Thumb single register in ARM processor.
2. Briefly discuss about the Advanced Microcontroller Bus Architecture (AMBA).
3. What are the data types supported by ARM programming high level languages?

Course Outcome 5(CO5): To explain the basics of real time operating systems and their use in embedded systems. (K2)

1. Discuss the importance of kernel in an operating system.
2. Compare process and thread.
3. Explain the role of events in inter task communication

SYLLABUS

Module 1: Introduction to Embedded Systems

Complex Systems and Microprocessors: Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors, The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing. The Embedded System Design Process: Requirements, Specification, Architecture Design, Designing Hardware and Software Components, System Integration. Formalisms for System Design: Structural Description, Behavioral Description, An embedded system design example. Embedded product development cycle (EDLC): Different phases of EDLC, EDLC models

Module 2: Embedded system interfacing and peripherals

Communication devices: Serial Communication Standards and Devices - UART, HDLC and SPI. Serial Bus Protocols - I 2C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus. Memory: Memory devices and systems – ROM-Flash, EEPROM, RAM-SRAM, DRAM, Cache memory, memory mapping and addresses, memory management unit–DMA. I/O Device: Interrupts-Interrupt sources, recognizing an interrupt, ISR – Device drivers for handling ISR, Shared data problem, Interrupt latency.

Module 3: ARM Processor fundamentals

ARM Processor architecture: The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools. ARM Assembly Language: Programming Data processing instructions, Data transfer instructions, Control flow instructions, writing simple assembly language programs. ARM Organization and Implementation: Three stage pipeline ARM organization, Five stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface.

Module 4: ARM Programming

Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment. The Thumb Instruction Set: The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications.

Architectural Support for System Development: The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA). Programming: Assembly and C language programming applications of embedded systems.

Module 5: Real Time Operating Systems

Operating system basics: Kernel, types of operating systems. Real time operating systems: Tasks, process, threads, multiprocessing and multi-tasking, task scheduling, types, threads and process scheduling, task communication, task synchronization, device drivers, choosing an RTOS.

Text Books

1. Raj kamal, Embedded Systems Architecture, Programming and Design, TMH, 2003
2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
3. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008
4. Steve Furber, ARM system-on-chip architecture, Addison Wesley, Second Edition, 2000

Reference Books

1. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
2. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002
3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Designing and Optimizing System Software, Morgan Kaufmann Publishers 2004
4. Frank Vahid and Tony Givargis, Embedded Systems Design – A Unified Hardware / Software Introduction, John Wiley, 2002.
5. Tammy Noergaard, Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers, Newnes – Elsevier 2ed, 2012
6. Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi, 2003
7. Lyla B. Das, Embedded Systems: An Integrated Approach, 1/e, Lyla B. Das, Embedded Systems, 2012

Model Question Paper

Reg No.: **Name:**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR

Course Code: ERT381

Course Name: EMBEDDED SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. Define an embedded system
2. Write any 3 challenges of embedded system design
3. Explain how an RS232 device is interfaced to a processor
4. What is interrupt latency?
5. Write the contents of CPSR register of ARM processor and their use.
6. Draw the five-stage pipeline architecture of ARM processor
7. What is the use of thumb instruction set in ARM processor?
8. What a note on ARM memory interface
9. What is a real time operating system?
10. What are tasks, processes and threads? [10 X 3= 30]

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. (a) What are the characteristics of an embedded system? Explain. [07 Marks]

(b) Explain the different phases of EDLC. [07 Marks]

OR

12. (a) Write different steps involved in the embedded system design process. [07 Marks]

(b) Explain the structural description of embedded system design. [07 Marks]

Module2

13.(a) What is serial and parallel port communication? Explain with the help of necessary diagrams. [07 Marks]

(b) What is interrupt? How interrupts are handled in a processor? Explain ISR. [07 Marks]

OR

14. (a) With the help of a diagram show how ROM and RAM are interfaced to a processor. Explain the read/write processes. [07 Marks]

(b) Explain how a memory management unit is used in a processor. What are its uses? What is DMA? [07 Marks]

Module3

15. (a) Write a note on ARM processor architecture and its registers. [07 Marks]

(b) Write a note on data processing and data transfer instructions with the help of examples [07 Marks]

OR

16. (a) What is pipeline architecture? Explain how an ARM instruction is executed in a 5 stage pipeline processor with the help of an example. [08 Marks]

(b) Write an ARM assembly language program to print text string "Hello World". [06 Marks]

Module-4

17. (a) Explain ARM floating point architecture and discuss how floating-point numbers are handled [07 Marks]

(b) Write a note on Thumb single register and multiple register data transfer instructions with the help of examples. [07 Marks]

OR

18.(a) What is Thumb instruction set? Why it is used? Explain Thumb programmers model. [07 Marks]

(b) Draw the block diagram of AMBA architecture. What are the different types of buses used in the architecture? [07 Marks]

Module 5

19. (a) What are the different services of Kernel? Explain different types of Kernels. [07Marks]

(b) Explain pre-emptive and non-pre-emptive scheduling algorithms with the help of an example. [07 Marks]

OR

20. (a) What are the basic functions of real time Kernel? Explain. [07 Marks]

(b) Write a note on the following (a) shared memory (b) message passing (c) deadlock [07 Marks]

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Introduction to Embedded Systems**	**8**
1.1	Complex Systems and Microprocessors: Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors.	1

1.2	The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing.	1
1.3	The Embedded System Design Process: Requirements, Specification, Architecture Design,	1
1.4	Designing Hardware and Software Components, System Integration.	1
1.5	Formalisms for System Design: Structural Description	1
1.6	Behavioral Description, An embedded system design example.	1
1.7	Embedded product development cycle (EDLC): Different phases of EDLC,	1
1.8	EDLC models	1
2	**Embedded system interfacing and peripherals**	**9**
2.1	Communication devices: Serial Communication Standards and Devices - UART, HDLC and SPI.	1
2.2	Serial Bus Protocols - I 2C Bus, CAN Bus and USB Bus.	1
2.3	Parallel communication standards ISA, PCI and PCI-X Bus.	1
2.4	Memory: Memory devices and systems – ROM-Flash, EEPROM, RAM-SRAM	1
2.5	DRAM, Cache memory, memory mapping and addresses,	1
2.6	memory management unit– DMA.	1
2.7	I/O Device: Interrupts-Interrupt sources, recognizing an interrupt	1
2.8	ISR – Device drivers for handling ISR	1
2.9	Shared data problem, Interrupt latency	1
3	**ARM Processor fundamentals**	**9**
.3.1	ARM Processor architecture: The Acorn RISC Machine	1
3.2	Architectural inheritance, The ARM programmer's model,	1
3.3	ARM development tools.	1
3.4	ARM Assembly Language: Programming Data processing instructions.	1
3.5	Data transfer instructions, Control flow instructions	1
3.6	writing simple assembly language programs.	1

3.7	ARM Organization and Implementation: Three stage pipeline ARM organization,	1
3.8	Five stage pipeline ARM organization, ARM instruction execution,	1
3.9	ARM implementation, The ARM coprocessor interface.	1
4	**ARM Programming**	**10**
4.1	Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types	1
4.2	The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment.	1
4.3	The Thumb Instruction Set: The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions,	1
4.4	Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions	1
4.5	Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications.	1
4.6	Architectural Support for System Development: The ARM memory interface.	1
4.7	The Advanced Microcontroller Bus Architecture (AMBA)	1
4.8	Programming: Assembly and C language programming applications of embedded systems. - Lecture 1	1
4.9	Programming: Assembly and C language programming applications of embedded systems. - Lecture 2	1
4.10	Applications of embedded systems.	1
5	**Real Time Operating Systems**	**9**
5.1	Operating system basics: Kernel	1
5.2	Types of operating systems.	1
5.3	Real time operating systems: Tasks, process, threads, process, threads	1
5.4	multiprocessing and multi-tasking,	1
5.5	task scheduling, types,	1
5.6	threads and process scheduling	1
5.7	Task communication, Task synchronization	1
5.8	Device drivers,	1
5.9	Choosing an RTOS.	1

CST 383	CONCEPTS IN MACHINE LEARNING	Category	L	T	P	Credit	Year of introduction
		VAC	3	1	0	4	2019

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning & the naive Bayes algorithm, support vector machines& kernels, basic clustering algorithms and dimensionality reduction methods. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Familiarity with basics in linear algebra, probability and Python programming.

	Course Outcomes
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.**(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate supervised learning concepts (regression, linear classification). **(Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine **(Cognitive Knowledge Level: Apply**)
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. (**Cognitive Knowledge Level**: **Apply**)
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓

CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓						✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percentage)**	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module-1 (Overview of machine learning)

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.

Module-2 (Supervised Learning)

Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.

Module-3 (Neural Networks (NN) and Support Vector Machines (SVM))

NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm.

SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).

Module-4 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.

Module-5 (Classification Assessment)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve(AUC. Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.

Text Book

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

Sample Course Level Assessment Questions

Course Outcome1(CO1):

1. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for θ, the probability of heads.
2. Suppose data $x_1, ..., x_n$ are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.
3. Suppose $x_1, ..., x_n$ are independent and identically distributed(iid) samples from a distribution with density

$$f_X(x \mid \theta) = \begin{cases} \dfrac{\theta x^{\theta-1}}{3^\theta}, & 0 \le x \le 3 \\ 0, & \text{otherwise} \end{cases}$$

   Find the maximum likelihood estimate(MLE) for θ.
4. Find the maximum likelihood estimator (MLE) and maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean v and variance β^2. What happens to the MLE and MAP estimators as the number of samples goes to infinity.

Course Outcome 2 (CO2):

1. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.
2. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
3. Suppose you have a three class problem where class label $y \in 0, 1, 2$ and each training example X has 3 binary attributes $X_1, X_2, X_3 \in 0, 1$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 3 (CO3):

1. What are support vectors and list any three properties of the support vector classifier solution?
2. Why do you use kernels to model a projection from attributes into a feature space, instead of simply projecting the dataset directly?
3. Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-z}$, where $z = (x-y)^2$.

4. Briefly explain one way in which using tanh instead of logistic activations makes optimization easier.
5. ReLU activation functions are most used in neural networks instead of the tanh activation function. Draw both activation functions and give a) an advantage of the ReLU function compared to the tanh function. b) a disadvantage of the ReLU function compared to the tanh function.

Course Outcome 4(CO4):

1. Describe cluster analysis? Identify two applications where cluster analysis can be applied to multimedia data?
2. Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):

(i) Compute the Euclidean distance between the two objects.

(ii) Compute the Manhattan distance between the two objects.

3. Use PCA to reduce the dimension from 2 to 1 for the design matrix ***X***.

$$X = \begin{bmatrix} 6 & -4 \\ -3 & 5 \\ -2 & 6 \\ 7 & -3 \end{bmatrix}$$

4. What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance?
5. Suppose that one runs a principal component analysis on a data set and tells that the percentage of variance explained by the first 3 components is 80%. How is this percentage of variance explained?

Course Outcome 5 (CO5):

1. Suppose that you are contacted by a food processing company that wants you to develop a classifier that detects whether a rat is present in an image. You collect a large dataset of images by crawling the web, and have annotators determine which images contain rats. This set of images can then be used as the training set for your classifier.
   a. Suggest a machine learning method to use for this classification task and evaluate its performance.
   b. After you have delivered your solution to the company, they get back to you and complain that when they evaluate on a new test set, they get precision and recall values that are much lower than what you reported to them. Explain what might have gone wrong and propose remedial measures .
2. A real estate firm would like to build a system that predicts the sale prices of a house. They create a spreadsheet containing information about 1,500 house sales in the Kochi

area. In addition to the price, there are 10 features describing the house, such as number of bedrooms, total indoor area, lot area, a swimming pool, location, etc. Explain how you would implement a machine learning model that would solve this prediction task. Give all steps you would carry out when developing it. Explain why the model you built is probably useless in the long run.

3. For a classifier, the confusion matrix is given by:

	+	-
+	9	9
-	1	5

What is the precision, recall and accuracy of that classifier?

Model Question Paper

QP CODE: PAGES:3

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 383

Course Name: CONCEPTS IN MACHINE LEARNING

Max.Marks:100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Define supervised learning? Name special cases of supervised learning depending on whether the inputs/outputs are categorical, or continuous.
2. Differentiate between Maximum Likelihood estimation (MLE) and Maximum a Posteriori (MAP) estimation?
3. What is overfitting and why is it a problem? Give an example of a method to reduce the risk of overfitting.
4. Specify the basic principle of gradient descent algorithm.
5. Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you

remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer.

6. Mention the primary motivation for using the kernel trick in machine learning algorithms?
7. Expectation maximization (EM) is designed to find a maximum likelihood setting of the parameters of a model when some of the data is missing. Does the algorithm converge? If so, do you obtain a locally or globally optimal set of parameters?
8. Illustrate the strength and weakness of k-means algorithm.
9. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.
10. How does bias and variance trade-off affect machine learning algorithms?

(10x3=30)

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. a) Suppose that ***X*** is a discrete random variable with the following probability mass function: where $0 \leq \theta \leq 1$ is a parameter. The following 10 independent observations

X	0	1	2	3
$P(X)$	$2\theta/3$	$\theta/3$	$2(1-\theta)/3$	$(1-\theta)/3$

were taken from such a distribution: ***(3, 0, 2, 1, 3, 2, 1, 0, 2, 1)***. What is the maximum likelihood estimate of θ. **(6)**

b) A gamma distribution with parameters α, β has the following density function, where $\Gamma(t)$ is the gamma function.

$$p(x) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$$

If the posterior distribution is in the same family as the prior distribution, then we say that the prior distribution is the conjugate prior for the likelihood function. Using the Gamma distribution as a prior, show that the Exponential distribution is a conjugate prior of the Gamma distribution. Also, find the maximum a posteriori estimator for the parameter of the Exponential distribution as a function of α and β. **(8)**

OR

12. a) Traffic between 8AM and 9AM at a certain place was measured by counting the number of vehicles that passed at that time. Suppose the counts follow a Poisson process. A random sample of 9 observations was collected, having observed the following number of vehicles: (95, 100, 80, 70, 110, 98, 97, 90, 70). Derive the maximum likelihood estimator for the

average number of vehicles that pass by that place between 8 AM and 9 AM, and compute the corresponding estimate using the given sample. **(7)**

b) Find the maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1, \ldots, x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean ν and variance β^2. **(7)**

13.a) Derive the gradient descent training rule assuming for the target function $o_d = w_0 + w_1x_1 + \ldots + w_nx_n$. Define explicitly the squared cost/error function E, assuming that a set of training examples D is provided, where each training example $d \in D$ is associated with the target output t_d. **(10)**

b) How can we interpret the output of a two-class logistic regression classifier as a probability? **(4)**

OR

14. a) In a two-class logistic regression model, the weight vector $w = [4, 3, 2, 1, 0]$. We apply it to some object that we would like to classify; the vectorized feature representation of this object is $x = [-2, 0, -3, 0.5, 3]$. What is the probability, according to the model, that this instance belongs to the positive class? **(6)**

b) The following dataset can be used to train a classifier that determines whether a given person is likely to own a car or not. There are three features: education level (primary, secondary, or university); residence (city or country); gender (female, male).

education	residence	gender	has car?
sec	country	female	yes
univ	country	female	yes
prim	city	male	no
univ	city	male	no
sec	city	female	no
sec	country	male	yes
prim	country	female	yes
univ	country	male	yes
sec	city	male	yes
prim	city	female	no
univ	city	female	no
prim	country	male	yes

Find the root attribute and justify your answer **(8)**

15. a) Consider a support vector machine whose input space is 2-D, and the inner products are computed by means of the kernel ***K(x, y) = (x.y + 1)²-1***, where ***x.y***denotes the ordinary inner product. Show that the mapping to feature space that is implicitly defined by this kernel is the mapping to 5-D given by **(10)**

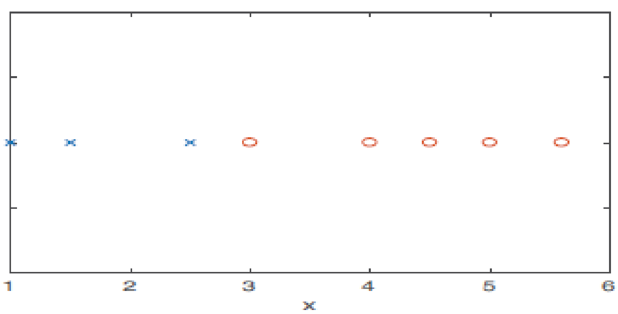
$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \rightarrow \phi(\mathbf{x}) = \begin{bmatrix} x_1^2 \\ x_2^2 \\ \sqrt{2}\, x_1 x_2 \\ \sqrt{2}\, x_1 \\ \sqrt{2}\, x_2 \end{bmatrix}.$$

b) What is the basic idea of a Support Vector Machine? **(4)**

OR

16. a) Explain how back propagation can be used to solve XOR problem which is not linearly separable. **(8)**

b) Consider the following one dimensional training data set, 'x' denotes negative examples and 'o' positive examples. The exact data points and their labels are given in the table. Suppose a SVM is used to classify this data. Indicate which are the support vectors and mark the decision boundary. Find the equation of the hyperplane. (6)



x	1	1.5	2.5	3	4	4.5	5	5.6
y	-1	-1	-1	1	1	1	1	1

17. a)Suppose that we have the following data (one variable). Use single linkage Agglomerative clustering to identify the clusters.
Daa: (2, 5, 9, 15, 16, 18, 25, 33, 33, 45). **(8)**

b) Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):

(i) Compute the Euclidean distance between the two objects.

(ii) Compute the Manhattan distance between the two objects.

(iii) Compute the Minkowski distance between the two objects, using p = 3 **(6)**

OR

18. a) Suppose that we have the following data:

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
(2,0)	(1,2)	(2,2)	(3,2)	(2,3)	(3,3)	(2,4)	(3,4)	(4,4)	(3,5)

Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible. **(10)**

b) List the steps involved in Principal Component Analysis. **(4)**

19. a) Suppose the dataset had 9700 cancer-free images from 10000 images from cancer patients. Find precision, recall and accuracy ? Is it a good classifier? Justify. **(8)**

Actual Class\ Predicted class	**cancer = yes**	**cancer = no**	**Total**
cancer = yes	90	210	300
cancer = no	140	9560	9700
Total	230	9770	10000

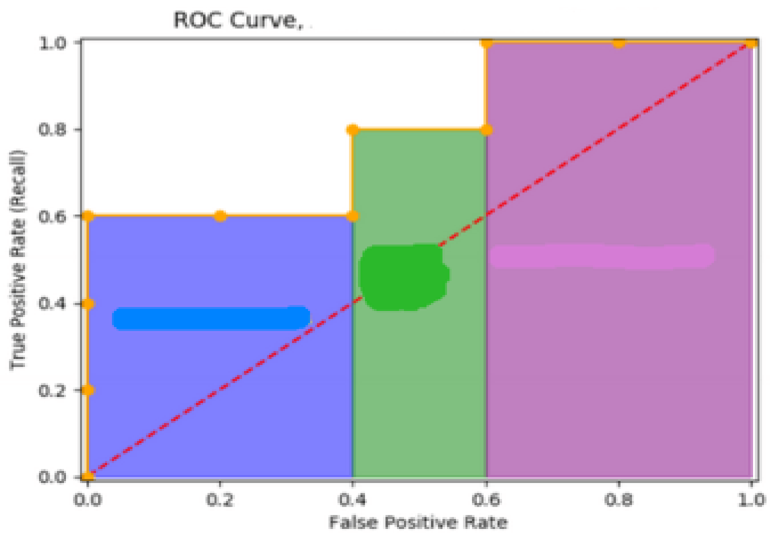
b) Suppose that you have a classification problem where our feature representation contains about 10,000,000 features. We would like to develop a classifier that can be deployed in a mobile phone, so preferably it should have a small memory footprint. Discuss one solution for how this can be done. **(6)**

OR

20. a) What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why? **(6)**

b) Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer. **(4)**

c) Given the following ROC Curve? Find the AUC? **(4)**



Teaching Plan

No	**Contents**	**No of Lecture Hrs**
	Module 1 :Overview of machine learning (7 hours)	
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (Text Book (TB) 1: Chapter 1)	1hour
1.2	Maximum likelihood estimation(MLE) (TB 1: Section 4.2)	1hour
1.3	Maximum likelihood estimation (MLE)- example (TB 1: Section 4.2)	1hour
1.4	Maximum a posteriori estimation(MAP) (TB 4: Section 6.2)	1hour
1.5	Maximum a posteriori estimation(MAP)-example (TB 4: Section 6.2)	1hour
1.6	Bayesian formulation (TB 1: Section 14.1, 14.2)	1hour
1.7	Bayesian formulation -example (TB 1: Section 14.1, 14.2)	1hour
	Module 2 : Supervised Learning (8 hours)	

2.1	Linear regression with one variable (TB 1: Section 2.6)	1hour
2.2	Multiple variables, Solution using gradient descent algorithm and matrix method (No derivation required) (TB 1: Section 5.8)	1hour
2.3	Overfitting in regression, Lasso and Ridge regularization	1hour
2.4	Logistic regression	1hour
2.5	Perceptron	1hour
2.6	Naive Bayes (TB 2: Section 18.2)	1hour
2.7	Decision trees (TB 2: Chapter 19)	1hour
2.8	Decision trees- ID3 algorithm (TB 2: Chapter 19)	1hour
Module 3 : Neural Networks and Support Vector Machines (TB 2: Chapter 21) (11 hours)		
3.1	Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU, Tanh)	1hour
3.2	Back Propagation Algorithm	1hour
3.3	Illustrative Example for Back Propagation	1hour
3.4	Introduction, Maximum Margin Hyperplane,	1hour
3.5	Mathematics behind Maximum Margin Classification	1hour
3.6	Formulation of maximum margin hyperplane and solution	1hour
3.7	Soft margin SVM	1hour
3.8	Solution of Soft margin SVM	1hour
3.9	Non-linear SVM	1hour
3.10	Kernels for learning non-linear functions and properties of kernel functions.	1hour
3.11	Example Kernels functions- Linear, RBF, Polynomial.	1hour
Module 4 : Unsupervised Learning (10 hours)		
4.1	Similarity measures- Minkowski distance measures(Manhattan, Euclidean), Cosine Similarity	1hour
4.2	Clustering - Hierarchical Clustering (TB 2: Chapter 14)	1hour
4.3	K-means partitional clustering (TB 2: Chapter 13)	1hour
4.4	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour
4.5	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour

4.6	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.7	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.8	Factor Analysis (TB 1: Section 6.4)	1hour
4.9	Multidimensional scaling (TB 1: Section 6.5)	1hour
4.10	Linear Discriminant Analysis (TB 1: Section 6.6)	1hour
Module 5 : Classification Assessment (8 hours)		
5.1	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC. (TB 2: Chapter 22.1)	1hour
5.2	Boot strapping, Cross validation	1hour
5.3	Ensemble methods- bagging	1hour
5.4	Ensemble methods- boosting	1hour
5.5	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.6	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.7	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour
5.8	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour

CST 385	CLIENT SERVER SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.

Prerequisite: **Basic knowledge in Computer**

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

	Course Outcomes
CO 1	Identify the basics of client/server systems and the driving force behind the development of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 2	Outline the architecture and classifications of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 3	Summarize the client/server network services for an application**(Cognitive Knowledge Level: Understand)**
CO 4	Identify management services and issues in network **(Cognitive Knowledge Level: Understand)**
CO 5	Outline the Client/Server technology in respect of databases and Client/Server database architecture **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓										✓
CO3	✓	✓										✓
CO4	✓											✓
CO5	✓	✓										✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Percentage)	Test 2 (Percentage)	
Remember	**40**	**40**	**40**
Understand	**40**	**40**	**40**
Apply	**20**	**20**	**20**
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test 1 (for theory, for 2 hrs) : **20 marks**

Continuous Assessment Test 2 (for lab, internal examination, for 2hrs) : **20 marks**

Internal Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), having 3 marks for each question. Students should answer all questions. Part B also contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), of which a student should answer any one. The questions should not have sub-divisions and each one carries 7 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 a 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 (CO1):

1. Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture.

Course Outcome 2 (CO2):

1. Explain the role of mainframe-centric model in Client/Server computing?

Course Outcome 3(CO3):

1. Describe the client server system development methodology? Explain different phases of System Integration Life-Cycle.

Course Outcome 4 (CO4):

1. Explain about network management and remote system management. How can security be provided to the network?

Course Outcome 5 (CO5):

1. Explain various types of Client/Server Database Architecture

Syllabus

Module – 1 (Introduction)

Introduction to Client/Server computing - Basic Client/Server Computing Model, Server for Every Client- File Server, Print Server, Application Server, Mail Server, Directory Services Server, Web Server, Database Server, Transaction Servers. Client/Server-Fat or Thin, Stateless or Stateful, Servers and Mainframes, Client/Server Functions. Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective.

Module -2 (Client/Server Classification)

Client/Server Types-Single Client/Single Server, Multiple Clients/Single Server, Multiple Clients/Multiple Servers, Integration With Distributed Computing, Alternatives To Client/Server Systems. Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems.Client/Server Topologies. Existing Client/Server Architecture. Architecture for Business Information System.

Module -3 (Client/Server Application Components)

Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services. Server- Detailed server functionality, Network operating system, Available platforms, Server operating system. Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages and disadvantages of Client/Server computing, Applications of Client/Server.

Module -4 (Client/ Server Systems Services and Support)

Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues.

Module -5(Client/Server Technology and Databases)

Client/Server Technology and Databases - Storing Data, Database System Architectures. Client/Server In Respect Of Databases- Client/Server Databases, Client/Server Database Computing, Database Computing Vs. Mainframe, PC/File Server Computing. Client/Server Database Architecture - Process-Per-Client Architecture, Multi-Threaded Architecture, Hybrid Architecture. Database Middleware Component - Application Programming Interface, Database Translator, Network Translator.

Text Book

1. Patrick Smith &Steve Guengerich, Client / Server Computing, PHI

2. Subhash Chandra Yadav, Sanjay Kumar Singh, An Introduction to Client/Server Computing, New Age International Publishers

Reference Books

1. Jeffrey D.Schank, "Novell's Guide to Client-Server Application & Architecture" Novell Press

2. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition, Third Edition

3. Dawna Travis Dewire, Client Server Computing — McGraw Hill

4. W.H.Inman, Developing Client Server Applications, BPB

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 385

Course Name : Client Server Systems

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Differentiate between Stateful and Stateless servers
2. List the different phases and activities of client/server system development methodology.
3. How does transmission protocol work in client/server applications?
4. List any six services in single system image environment.
5. Specify the role of the client in Client/Server computing and also list any six services provided by the client.
6. Why do most RPC system support call by value semantics for parameter passing?
7. What do you mean by a thin client network? List three advantages of the Thin

Client Network system.

8. How are connectivity and interoperability between .client/server achieved?

9. One disadvantage of the Client/Server system is lack of control in a Database Management environment. Justify.

10. Explain the DBMS concept in client/server architecture.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Differentiate between Transaction server and Data server system with examples. **(7)**

(b) Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture. **(7)**

OR

12. (a) Explain various Clients/Server system development tools. **(6)**

(b) Classify and describe the driving forces that drive the move to Client/Server computing. **(8)**

13. (a) Explain the role of mainframe-centric model in Client/Server computing? **(5)**

(b) Describe the three types of Client/Server systems in existence **(9)**

OR

14. (a) List and explain the general forces behind the architecture for business information systems **(7)**

(b) Explain the different distribution styles. **(7)**

15. (a) Illustrate the concept of rightsizing and downsizing in Client/Server Computing **(7)**

(b) What is client server system development methodology? Explain the **(7)**

different phases of System Integration Life-Cycle.

OR

16. (a) In Client/Server computing, explain the following with examples **(10)**

    i. Dynamic Data Exchange
    ii. RPC, Remote Procedure Call
    iii. Remote Boot Service
    iv. Diskless Computer
    v. Object-linking and embedding

    (b) Explain the functions and features of Network Operating System **(4)**

17. (a) Explain about network management and remote system management. How can security be provided to the network ? **(10)**

    (b) In client server architecture, what do you mean by Availability, Reliability, Serviceability and Security? Explain with examples. **(4)**

OR

18. (a) Client server is modular infrastructure, this is intended to improve Usability, Flexibility, Interoperability and Scalability. Explain each term with an example, in each case how it helps to improve the functionality of client server architecture. **(7)**

    (b) Explain about network management and remote system management. How can security be provided to network? **(7)**

19. (a) Explain the different types of Client/Server Database Architecture **(9)**

    (b) List and explain the main components of Database middleware **(5)**

OR

20. (a) Discuss types of database utilities, tools and their functions **(7)**

    (b) Discuss about the role of traditional and web databases in handling client/server based applications. **(7)**

Teaching Plan

Module- 1(Introduction)		**(10 hours)**
1.1	Basic Client/Server Computing Model	1 hour
1.2	Server for Every Client- File Server, Print Server	1 hour
1.3	Application Server, Mail Server, Directory Services Server	1 hour
1.4	Web Server, Database Server	1 hour
1.5	Transaction Servers	1 hour
1.6	Client/Server-Fat or Thin	1 hour
1.7	Stateless or Stateful	1 hour
1.8	Servers and Mainframes	1 hour
1.9	Client/Server Functions	1 hour
1.10	Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective	1 hour
Module- 2 (Client/Server Classification)		**(10 hours)**
2.1	Client/Server Types-Single Client/Single Server	1 hour
2.2	Multiple Clients/Single Server, Multiple Clients/Multiple Servers	1 hour
2.3	Integration With Distributed Computing	1 hour
2.4	Alternatives To Client/Server Systems	1 hour
2.5	Classification of Client/Server Systems- Two-Tier Computing, Middleware	1 hour
2.6	Three-Tier Computing- Model View Controller (MVC)	1 hour
2.7	Principles behind Client/Server Systems.	1 hour
2.8	Client/Server Topologies	1 hour
2.9	Existing Client/Server Architecture	1 hour
2.10	Architecture for Business Information System	1 hour
Module -3 (Client/Server Application Components)		**(9 hours)**
3.1	The client: Services, Request for services, RPC	1 hour
3.2	Windows services, Print services, Remote boot services	1 hour

3.3	Utility Services & Other Services	1 hour
3.4	Server- Detailed server functionality, Network operating system	1 hour
3.5	Available platforms, Server operating system	1 hour
3.6	Organizational Expectations, Improving performance of client/server applications	1 hour
3.7	Single system image, Downsizing and Rightsizing	1 hour
3.8	Advantages and disadvantages of Client/Server computing	1 hour
3.9	Applications of Client/Server	1 hour
Module -4 (Client/ Server Systems Services and Support)		**(8 hours)**
4.1	Services and Support, System administration	1 hour
4.2	Availability, Reliability	1 hour
4.3	Scalability, Observability, Agility	1 hour
4.4	Serviceability, Software Distribution	1 hour
4.5	Performance	1 hour
4.6	Network management	1 hour
4.7	Remote Systems Management- RDP, Telnet, SSH	1 hour
4.8	Security, LAN and Network Management issues	1 hour
Module -5(Client/Server Technology and Databases)		**(8 hours)**
5.1	Client/Server Technology and Databases - Storing Data	1 hour
5.2	Database System Architectures	1 hour
5.3	Client/Server In Respect Of Databases- Client/Server Databases	1 hour
5.4	Client/Server Database Computing	1 hour
5.5	Database Computing Vs. Mainframe, PC/File Server Computing	1 hour
5.	Client/Server Database Architecture - Process-Per-Client Architecture	1 hour
5.7	Multi-Threaded Architecture, Hybrid Architecture	1 hour
5.8	Database Middleware Component - Application Programming Interface, Database Translator, Network Translator	1 hour

SEMESTER V

HONOURS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT393	**FPGA Based System Design**	VAC	3	1	0	4

Preamble: This course aims to develop the skill of FPGA based system design.

Prerequisite: ERT 203 Digital Systems and VLSI Design

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

CO 1	Design simple digital systems with programmable logic devices **(Cognitive Knowledge Level: Apply)**
CO 2	Explain the programmable logic devices **(Cognitive Knowledge Level: Understand)**
CO 3	Explain the architecture of FPGA **(Cognitive Knowledge Level: Understand)**
CO 4	Understand the design considerations of FPGA **(Cognitive Knowledge Level: Understand)**
CO 5	Design simple combinational and sequential circuits using FPGA **(Cognitive Knowledge Level: 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	✓	✓			✓							✓
CO 2	✓	✓			✓							✓
CO 3	✓	✓			✓							✓
CO 4	✓	✓			✓							✓
CO 5	✓	✓			✓							✓

Abstract POs defined by National Board of Accreditation		
Broad PO	**PO#**	**Broad PO**
Engineering Knowledge	**PO7**	Environment and Sustainability
Problem Analysis	**PO8**	Ethics
Design/Development of solutions	**PO9**	Individual and teamwork
Conduct investigations of complex problems	**PO10**	Communication
Modern tool usage	**PO11**	Project Management and Finance
The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10

Understand	30	30	60
Apply	10	10	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10marks

Continuous Assessment Test (2numbers): 25marks

Assignment/Quiz/Course project: 15marks

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): Design simple digital systems with programmable logic devices

1. Design simple digital systems with programmable logic devices.
2. Design a decade counter using Verilog.
3. Implement a full adder using ROM

Course Outcome 2 (CO2): Explain the programmable logic devices

1. Differentiate PLA with PAL.
2. Design the function F=XYZ'+Y' Z+X Y' using PLA

Course Outcome 3 (CO3): Explain the architecture of FPGA

1. Compare coarse- and fine-grained FPGA.
2. Explain the architecture of logic block of FPGA

Course Outcome 4 (CO4): Understand the design considerations of FPGA

1. What are the vendor specific issues in FPGA design.
2. Compare Timing and Power dissipation in a typical FPGA.

Course Outcome 5 (CO5): Design simple combinational and sequential circuits using FPGA.

1. Implement a counter in Xilinx Virtex.
2. Explain how sequential circuit can be mapped into Xilinx Virtex LUT.

SYLLABUS

Module 1: Introduction

Digital system design options and tradeoffs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modelling and simulation, Hardware description languages (emphasis on Verilog), combinational and sequential design, state machine design, synthesis issues, test benches.

Module 2: Programmable logic Devices

ROM, PLA, PAL, CPLD, FPGA Features, Limitations, Architectures and Programming. Implementation of MSI circuits using Programmable logic Devices.

Module 3: FPGA architecture

FPGA Architectural options, granularity of function and wiring resources, coarse V/s fine grained, Logic block architecture: FPGA logic cells, timing models, I/O block architecture: Input and Output cell characteristics, clock input, Timing

Module 4: Placement and Routing

Programmable interconnect - Partitioning and Placement, Routing resources, delays. Applications - Embedded system design using FPGAs, DSP using FPGAs

Module 5: Commercial FPGAs

Xilinx (Different series description only), Case study Xilinx Virtex: implementation of simple combinational and sequential circuits.

Text Books

1. FPGA-Based System Design Wayne Wolf, Verlag: Prentice Hall
2. Modern VLSI Design: System-on-Chip Design (3rd Edition) Wayne Wolf, Verlag

References:

1. Field Programmable Gate Array Technology - S. Trimberger, Edr, 1994, Kluwer Academic
2. Digital Design Using Field Programmable Gate Array, P.K. Chan & S. Mourad, 1994,
3. Prentice Hall
4. Field programmable gate array, S. Brown, R.J. Francis, J. Rose, Z.G. Vranesic, 2007, BS

Model Question Paper

Reg No.:______________ **Name:_______**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B. TECH DEGREE EXAMINATION

MONTH AND YEAR
Course Code: ERT393 FPGA Based System Design

Course Name: EMBEDDED SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What are the synthesis issues in FPGA design?	K2
2. Describe FPGA design methodology.	K2
3. Differentiate PLA with PAL	K2
4. What are the limitations of FPGA.	K2
5. Compare coarse- and fine-grained FPGA architecture.	K2
6. What are the timing models in logic block architecture.	K2
7. List the applications of FPGA.	K2
8. Describe routing resources in FPGA routing.	K2
9. Describe how a combinational circuit can be mapped into Xilinx Virtex LUT.	K2
10. List different commercially available FPGAs.	K2

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. (a) Design a full adder using Verilog.	7 CO1 K3
(b) Explain behavioural modelling and simulation with an example.	7 CO1 K2

OR

12. (a) What is FSM? How it is used for FPGA.	7 CO1 K2
(b) Explain the purpose of test bench and how it is written in a HDL.	7 CO1 K2

Module2

13. (a)Design the function F=XYZ’+Y’ Z+X Y’ using PLA	8 CO2 K3
(b) Compare CPLD with FPGA	6 CO2 K2

OR

14. (a) Implement the following Boolean function using PAL: $F(w, x, y, z) = \Sigma m\ (0, 2, 4, 10, 11, 12, 14, 15)$	8 CO2 K3
(b) Draw the structure of PAL and explain it.	6 CO2 K2

Module3

15. (a) Draw and explain I/O block architecture of FPGA.	7 CO2 K2
(b) Draw and explain coarse grained FPGA architecture.	7 CO2 K2

OR

16. (a) Explain timing in Logic block and I/O block.	7 CO2 K2
(b) Draw and explain fine grained FPGA architecture.	7 CO2 K2

Module-4

17. (a) Explain partitioning and placement processes in FPGA	8 CO4 K2
(b) Explain embedded system design using FPGAs	6 CO4 K2

OR

18. (a) Explain the delays associated with placement and routing	7 CO4 K2
(b) Explain DSP design using FPGAs	7 CO4 K2

Module 5

19. (a) With neat diagram explain the architecture of Xilinx Virtex IOB. 7 CO3 K2
(b) Design a four bit up counter with parallel load feature using Xilinx Virtex. 7 CO3 K3

OR

20. (a) Explain the mapping of combinational and sequential circuits using LUTs. 5 CO3 K3
(b) Explain the architecture of Xilinx Virtex CLB 9 CO3 K2

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures (40 hours)
1	**Introduction**	**(9 hours)**
1.1	Digital system design options and tradeoffs	1
1.2	Design methodology and technology overview	1
1.3	High Level System Architecture and Specification: Behavioral modelling and simulation – Lecture 1	1
1.4	High Level System Architecture and Specification: Behavioral modelling and simulation - Lecture 2	1
1.5	Hardware description languages, combinational and sequential design - Lecture 1	1
1.6	Hardware description languages, combinational and sequential design - Lecture 2	1
1.7	State machine design, synthesis issues, test benches. - Lecture 1	1
1.8	State machine design, synthesis issues, test benches. - Lecture 2	1
1.9	State machine design, synthesis issues, test benches. - Lecture 3	1
2	**Programmable logic Devices**	**(9 hours)**
2.1	ROM, PLA - Lecture 1	1
2.2	ROM, PLA - Lecture 2	1
2.3	PAL, CPLD - Lecture 1	1
2.4	PAL, CPLD - Lecture 2	1
2.5	FPGA Features, Limitations, Architectures and Programming. - Lecture 1	1
2.6	FPGA Features, Limitations, Architectures and Programming. - Lecture 2	1
2.7	Implementation of MSI circuits using Programmable logic - Lecture 1	1
2.8	Implementation of MSI circuits using Programmable logic - Lecture 2	1
2.9	Implementation of MSI circuits using Programmable logic - Lecture 3	1
3	**FPGA architecture**	**(7 hours)**

3.1	FPGA Architectural options	1
3.2	Granularity of function and wiring resources, coarse V/s fine grained - Lecture 1	1
3.4	Granularity of function and wiring resources, coarse V/s fine grained - Lecture 2	1
3.3	Logic block architecture: FPGA logic cells, timing models - Lecture 1	1
3.5	Logic block architecture: FPGA logic cells, timing models - Lecture 2	1
3.6	I/O block architecture: Input and Output cell characteristics, clock input, Timing - Lecture 1	1
3.7	I/O block architecture: Input and Output cell characteristics, clock input, Timing - Lecture 2	1
4	**Placement and Routing**	**(7 hours)**
4.1	Programmable interconnect - Partitioning and Placement - Lecture 1	1
4.2	Programmable interconnect - Partitioning and Placement - Lecture 2	1
4.3	Routing resources, delays - Lecture 1	1
4.4	Routing resources, delays - Lecture 2	1
4.5	Applications -Embedded system design using FPGAs, DSP using FPGAs – Lecture 1	1
4.6	Applications -Embedded system design using FPGAs, DSP using FPGAs - Lecture 2	1
4.7	DSP using FPGAs	1
5	**Commercial FPGAs**	**(8 hours)**
5.1	Xilinx (Different series description only) - Lecture 1	1
5.2	Xilinx (Different series description only) - Lecture 2	1
5.3	Case study Xilinx Virtex - Lecture 1	1
5.4	Case study Xilinx Virtex - Lecture 2	1
5.5	Case study Xilinx Virtex - Lecture 3	1
5.6	Implementation of simple combinational and sequential circuits - Lecture 1	1
5.7	Implementation of simple combinational and sequential circuits - Lecture 2	1
5.8	Implementation of simple combinational and sequential circuits - Lecture 3	1

CST 393	CRYPTOGRAPHIC ALGORITHMS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The course on Cryptographic Algorithms aims at exploring various algorithms deployed in offering confidentiality, integrity, authentication and non-repudiation services. This course covers classical encryption techniques, symmetric and public key crypto-system, key exchange and management, and authentication functions. The concepts covered in this course enable the learners in effective use of cryptographic algorithms for real life applications.

Prerequisite: A sound background in Number Theory**.**

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

CO1	Identify the security services provided for different types of security attacks. (**Cognitive Knowledge Level : Understand**)
CO2	Summarize the classical encryption techniques for information hiding. (**Cognitive Knowledge Level: Apply**)
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.(**Cognitive Knowledge Level: Apply**)
CO4	Interpret key management techniques for secure communication.(**Cognitive Knowledge Level: Understand)**
CO5	Summarize message authentication functions in a secure communication scenario.(**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔									✔

CO2	✓	✓	✓		✓	✓						✓
CO3	✓	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓	✓	✓						✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percent**	

		age)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction to the Concepts of Security)

Need for security, Security approaches, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques - Substitution techniques, Transposition techniques. Stream cipher, Block cipher, Public key cryptosystems vs. Symmetric key cryptosystems, Encrypting communication channels.

Module-2 (Symmetric Key Cryptosystems)

Overview of symmetric key cryptography, Block cipher principles, Data Encryption Standard (DES), Differential and Linear cryptanalysis, Double DES, Triple DES, International Data Encryption Algorithm (IDEA), Advanced Encryption Algorithm (AES),Block cipher modes of operation, Stream cipher, RC4.

Module-3 (Public Key Cryptosystems)

Principles of public key cryptosystems, RSA algorithm, RSA illustration, Attacks, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems.

Module-4 (Key Management)

Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of public keys, Generating keys, transferring keys, Verifying keys, Updating keys, Storing keys, Backup keys, Compromised keys, Public key infrastructure.

Module – 5 (Authentication)

Authentication requirements, Authentication functions, Message authentication codes (MAC), Hash functions, Security of Hash functions and MAC, Message Digest 5 (MD5), Secure Hash Algorithm (SHA)-512, Hash-based Message Authentication Code (HMAC), Cipher-based Message Authentication Code (CMAC), X.509 Authentication services.

Text Books

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Edu, 6e.
2. Bruice Schneier, Applied Cryptography Protocols, Algorithms and source code in C, Wiley,2e.

References

1. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2e.

2. Johannes A. Buchmann, Introduction to Cryptography, Springer, 2e.

3. DouglasR. Stinson, Cryptography Theory and Practice, 3e,Chapman & Hall/CRC, 2006.

4. Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2011.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Consider an automated teller machine (ATM) in which users provide a personal identification number (PIN) and a card for account access. Give examples of confidentiality, integrity, and availability requirements associated with the system and, in each case, indicate the degree of importance of the requirement.

2. Discuss the different security services provided for preventing security attacks.

Course Outcome 2 (CO2):

1. The encryption key in a transposition cipher is (3,2,6,1,5,4). Find the decryption key

2.Discuss the process of encryption in Vernam cipher

Course Outcome 3 (CO3):

1. Devise a meet-in-the-middle attack for a triple DES.

2. Write an algorithm for the InvSubBytes transformation and implement using python (**Assignment**)
3. Consider the following elliptic curve signature scheme. We have a global elliptic curve, prime *p*, and “generator” G. Alice picks a private signing key X_A and forms the public verifying $Y_A = X_A G$. To sign a message *M*:
   - Alice picks a value k
   - Alice sends Bob *M*, k and the signature $S = M - kX_A G$.
   - Bob verifies that $M = S + kY_A$.

   Show that the verification process produces an equality if the signature is valid.
4. Write an algorithm to add two points on an elliptic curve over GF(*p*) and implement using Python. **(Assignment)**
5. Write an algorithm for encryption using knapsack cryptosystem and implement using Java. **(Assignment)**

Course Outcome4 (CO4):

1. List four general categories of schemes for the distribution of public keys.
2. What are the essential ingredients of a public-key directory?

Course Outcome 5 (CO5):

1. State the value of the length field in SHA-512 if the length of the message is 1919 bits and 1920 bits.
2. Write an algorithm in pseudo code for HMAC and implement using Python (**Assignment**)

Model Question Paper

QP CODE:

Reg No:_____________

Name :______________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(HONORS), MONTH & YEAR

Course Code: CST 393

Course Name: Cryptographic Algorithms

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

PART A

Answer all Questions. Each question carries 3 Marks

1. State the two approaches in attacking a cipher.
2. Define Substitution Cipher. Encrypt using one time pad M = HONORS and K = CIPHER.
3. Specify the purpose of S-Boxes in Data Encryption Standard (DES).
4. Differentiate between diffusion and confusion.
5. Perform encryption using RSA Algorithm for the following p=7; q=11; e=13; M=5.
6. Is Diffie-Hellman key exchange protocol vulnerable? Justify.
7. List the techniques for distribution of public keys.
8. Define a certificate authority and its relation to public key cryptography.
9. Distinguish between integrity and message authentication.
10. What types of attacks are addressed by message authentication?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) With a neat sketch, Explain OSI Security architecture model. **(8)**

(b) How does link encryption differ from end-to-end encryption? Explain. **(6)**

OR

12. (a) Encrypt the text "cryptography" using the Hill Cipher with the key $\begin{pmatrix} 9 & 4 \\ 5 & 7 \end{pmatrix}$. Show the calculations. **(8)**

(b) Illustrate the steps involved in encrypting a plain text using playfair cipher with an example. **(6)**

13. (a) With a neat sketch, explain a single round in DES. **10**

(b) Explain encryption and decryption using 2 keys and 3 keys of triple DES. **(4)**

OR

14. (a) Explain the block cipher modes i) Cipher feedback mode ii) Output feedback mode. **(8)**

(b) Describe the four types of transformations in AES. **(6)**

15. (a) Write an algorithm for generating public and private key using Elliptical curve cryptography. **(10)**

(b) The equation $y^2=x^3+x+1$, the calculation is done modulo 13. Add two points R= P+Q, where P= (4,2) and Q= (10,6). **(4)**

OR

16. User A and B use the Diffie-Hellman key exchange technique with a common prime q=71 and primitive root alpha=7.

(a) If user A has private key X_A =3, What is A's public key Y_A? **(7)**

(b) If user B has private key X_B =6, What is A's public key Y_B? **(7)**

17. (a) Define a session key and show how a KDC can create can create a session key between Alice and Bob. **(7)**

(b) What are the requirements for the use of a public-key certificate scheme? **(7)**

OR

18. (a) What are the core components of a PKI? Briefly describe each component. **(8)**

(b) Describe the following (i) Updating keys (ii) Compromised Keys. **(6)**

19. (a) Describe how SHA-512 logic produce message digest **(10)**

(b) Distinguish between HMAC and CMAC **(4)**

OR

20. (a) Specify the format for X.509 certificate. Explain the steps required to obtain user's certificate. **(7)**

(b) With suitable block diagrams, explain the types of functions that may be used to produce an authenticator. **(8)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Introduction to the Concepts of Security) (9 hrs)		
1.1	Need for security, Security approaches	1 hour
1.2	Principles of security, Types of attacks	1 hour
1.3	OSI Security Architecture	1 hour
1.4	Classical encryption techniques: Substitution techniques(Caesar cipher, Monoalphabetic cipher, Playfair cipher)	1 hour
1.5	Classical encryption techniques: Substitution techniques (Hill cipher, Polyalphabetic cipher, One-time pad)	1 hour
1.6	Classical encryption techniques: Transposition techniques	1 hour
1.7	Stream cipher, Block cipher	1 hour
1.8	Public- key cryptosystems vs. Symmetric key cryptosystems	1 hour
1.9	Encrypting communication channels	1 hour
Module - 2 (Symmetric key cryptosystems) (11 hrs)		
2.1	Overview of symmetric key cryptography	1 hour
2.2	Block cipher principles	1 hour
2.3	Data Encryption Standard (DES)	1 hour
2.4	DES design criteria	1 hour
2.5	Differential and Linear cryptanalysis	1 hour
2.6	Double DES, Triple DES	1 hour

2.7	IDEA	1 hour
2.8	Advanced Encryption Algorithm (AES structure)	1 hour
2.9	Advanced Encryption Algorithm (Transformations)	1 hour
2.10	Block cipher modes of operation	1 hour
2.11	Stream cipher, RC4	1 hour
	Module - 3 (Public key cryptosystems) (8 hrs)	
3.1	Principles of public key cryptosystems	1 hour
3.2	RSA algorithm	1 hour
3.3	RSA illustration, Attacks	1 hour
3.4	ElGamal cryptographic system	1 hour
3.5	Knapsack algorithm	1 hour
3.6	Diffie-Hellman key exchange algorithm	1 hour
3.7	Elliptical curve cryptosystems(Elliptical curve arithmetic)	1 hour
3.8	Elliptical curve cryptosystems (Elliptical curve algorithm)	1 hour
	Module - 4 (Key Management) (8 hrs) [Text book-2]	
4.1	Symmetric key distribution using symmetric encryption	1 hour
4.2	Symmetric key distribution using asymmetric encryption	1 hour
4.3	Distribution of public keys	1 hour
4.4	Generating keys, Transferring keys	1 hour

4.5	Verifying keys, Updating keys	1 hour
4.6	Storing keys, Backup keys	1 hour
4.7	Compromised keys	1 hour
4.8	Public key infrastructure	1 hour
Module - 5 (Authentication) (9 hrs)		
5.1	Authentication requirements	1 hour
5.2	Authentication functions	1 hour
5.3	Message Authentication Codes (MAC)	1 hour
5.4	Hash functions	1 hour
5.5	Security of Hash functions and MAC	1 hour
5.6	MD5	1 hour
5.7	SHA-512	1 hour
5.8	HMAC, CMAC	1 hour
5.9	X.509 Authentication services	1 hour

CST 395	NEURAL NETWORKS AND DEEP LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

Neural networks is a biologically inspired programming paradigm which enables a computer to learn from observational data and deep learning is a powerful set of techniques for training neural networks. This course introduces the key concepts in neural networks, its architecture and learning paradigms, optimization techniques, basic concepts in deep learning, Convolutional Neural Networks and Recurrent Neural Networks. The students will be able to provide best solutions to real world problems in domains such as computer vision and natural language processing.

Prerequisite: A Sound knowledge in Computational fundamentals of machine learning

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

CO1	Demonstrate the basic concepts of machine learning models and performance measures. **(Cognitive Knowledge Level : Understand)**
CO2	Illustrate the basic concepts of neural networks and its practical issues**(Cognitive Knowledge Level : Apply)**
CO3	Outline the standard regularization and optimization techniques for deep neural networks (**Cognitive Knowledge Level : Understand)**
CO4	Build CNN and RNN models for different use cases. **(Cognitive Knowledge Level : Apply)**
CO5	Explain the concepts of modern RNNs like LSTM, GRU **(Cognitive Knowledge Level : Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓								✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (%)	Test2 (%)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern

Attendance	**10 marks**
Continuous Assessment Tests	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have a maximum 2 subdivisions and carry 14 marks.

Syllabus

Module - 1 (Basics of Machine Learning)

Machine Learning basics - Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, Receiver Operating Characteristic curve(ROC), Area Under Curve(AUC).

Module -2 (Neural Networks)

Introduction to neural networks -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.

Module 3 (Deep learning)

Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.

Module -4 (Convolutional Neural Network)

Convolutional Neural Networks – Convolution operation, Motivation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST.

Module- 5 (Recurrent Neural Network)

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study - Natural Language Processing.

Text Book

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Reference Books

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Predict the price of a 1000 square feet house using the regression model generated from the following data.

No.	Square feet	Price(Lakhs)
1	500	5
2	900	10
3	1200	13
4	1500	18
5	2000	25
6	2500	32
7	2700	35

2. Consider a two-class classification problem of predicting whether a photograph contains a man or a woman. Suppose we have a test dataset of 10 records with expected outcomes and a set of predictions from our classification algorithm. Compute the confusion matrix, accuracy, precision, recall, sensitivity and specificity on the following data.

Sl.**No.**	Actual	Predicted
1	man	woman
2	man	man
3	woman	woman
4	man	man

5	man	woman
6	woman	woman
7	woman	man
8	man	man
9	man	woman
10	woman	woman

Course Outcome 2 (CO2):

1. Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
2. Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.

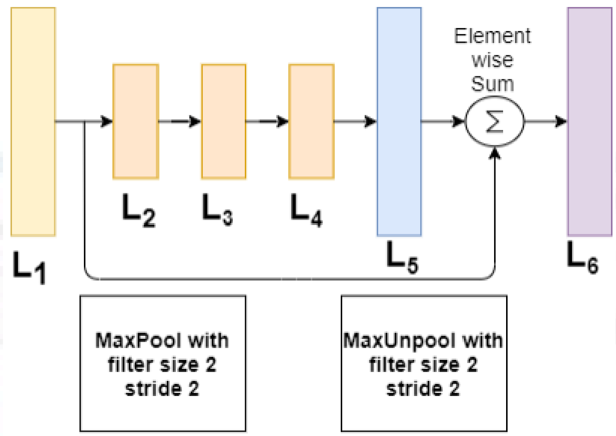
Course Outcome 3 (CO3):

1. Derive a mathematical expression to show L2 regularization as weight decay.
2. Explain how L2 regularization improves the performance of deep feed forward neural networks.
3. Explain how L1 regularization method leads to weight sparsity.

Course Outcome 4 (CO4):

1. Draw and explain the architecture of convolutional neural networks.
2. You are given a classification problem to classify the handwritten digits. Suggest a learning and/or inference machine with its architecture, an objective function, and an optimization routine, along with how input and output will be prepared for the classifier.
3. In a Deep CNN architecture the feature map L_1 was processed by the following operations as shown in the figure. First down sampled using max pool operation of size 2 and stride 2, and three convolution operations and finally max unpool operation and followed by an element wise sum. The feature map L_1 and L_4 are given below. Compute the matrix L6.

$$L_1 = \begin{matrix} 10 & 20 & 15 & 22 \\ 20 & 16 & 28 & 30 \\ 30 & 12 & 20 & 16 \\ 20 & 20 & 40 & 12 \end{matrix} \qquad L_4 = \begin{matrix} 10 & 20 \\ 20 & 30 \end{matrix}$$



4. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Course Outcome 5 (CO5):

1. Draw and explain the architecture of LSTM.
2. List the differences between LSTM and GRU

Model Question Paper

QP CODE: **PAGES:4**

Reg No:______________

Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(HONORS), MONTH & YEAR

Course Code: CST 395

Course Name: Neural Networks and Deep Learning

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

PART A

Answer all Questions. Each question carries 3 Marks

1. List and compare the types of machine learning algorithms
2. Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the

accuracy, precision and recall for the data

3. Illustrate the limitation of a single layer perceptron with an example

4. Specify the advantages of ReLU over sigmoid activation function.

5. Derive weight updating rule in gradient descent when the error function is a) mean squared error b) cross entropy

6. List any three methods to prevent overfitting in neural networks

7. What happens if the stride of the convolutional layer increases? What can be the maximum stride? Justify your answer.

8. Consider an activation volume of size 13×13×64 and a filter of size 3×3×64. Discuss whether it is possible to perform convolutions with strides 2, 3 and 5. Justify your answer in each case.

9. How does a recursive neural network work?

10. List down three differences between LSTM and RNN

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Prove that the decision boundary of binary logistic regression is linear **(9)**

(b) Given the following data, construct the ROC curve of the data. Compute the AUC. **(5)**

Threshold	**TP**	TN	FP	FN
1	0	25	0	29
2	7	25	0	22
3	18	24	1	11
4	26	20	5	3
5	29	11	14	0

6	29	0	25	0
7	29	0	25	0

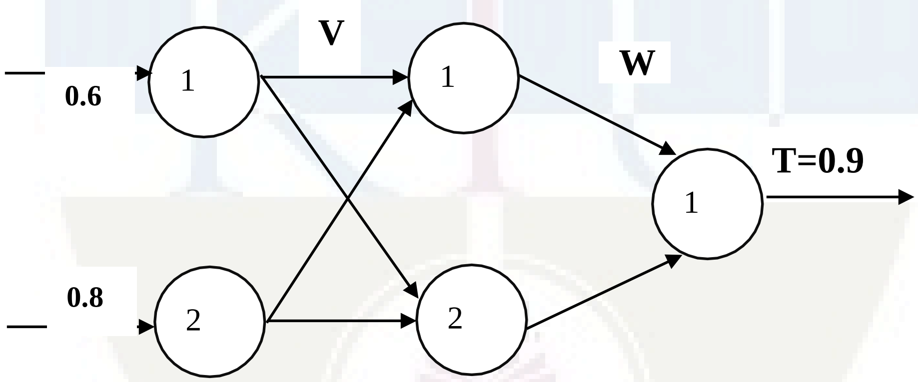
OR

12. (a) With an example classification problem, explain the following terms:
a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance **(8)**

(b) Determine the regression equation by finding the regression slope coefficient and the intercept value using the following data. **(6)**

x	55	60	65	70	80
y	52	54	56	58	62

13. (a) Update the parameters V_{11} in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V_{11}= 0.2, V_{12}=0.1, V_{21}=0.1, V_{22}=0.3, V_{11}=0.2, W_{11}=0.5, W_{21}=0.2 **(10)**

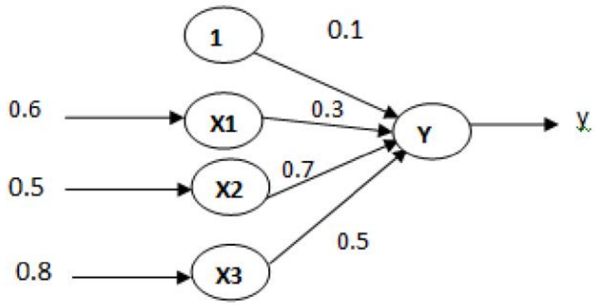


(b) Explain the importance of choosing the right step size in neural networks **(4)**

OR

14. (a) Explain in detail any four practical issues in neural network training **(8)**

(b) Calculate the output of the following neuron Y with the activation function as a) binary sigmoid b) tanh c)ReLU **(6)**



15. (a) Explain, what might happen in ADAGRAD, where momentum is expressed as $\Delta x_t = -\eta g_t / \sqrt{(\sum_{\tau=1}^{t} g_\tau^2)}$ where the denominator computes the L2 norm of all previous gradients on a per-dimension basis and η is a global learning rate shared by all dimensions. **(6)**

(b) Differentiate gradient descent with and without momentum. Give equations for weight updation in GD with and without momentum. Illustrate plateaus, saddle points and slowly varying gradients. **(8)**

OR

16. (a) Suppose a supervised learning problem is given to model a deep feed forward neural network. Suggest solutions for the following a) small sized dataset for training b) dataset with both labelled and unlabeled data c) large data set but data from different distribution **(9)**

(b) Describe the effect in bias and variance when a neural network is modified with more number of hidden units followed with dropout regularization. **(5)**

17. (a) Draw and explain the architecture of Convolutional Neural Networks **(8)**

(b) Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved? **(6)**

OR

18. (a) Explain the following convolution functions a)tensors b) kernel flipping c) down sampling d) strides e) zero padding. **(10)**

	(b)	What is the motivation behind convolution neural networks?	**(4)**
19.	(a)	Describe how an LSTM takes care of the vanishing gradient problem. Use some hypothetical numbers for input and output signals to explain the concept	**(8)**
	(b)	Explain the architecture of Recurrent Neural Networks	**(6)**

OR

20.	(a)	Explain LSTM based solution for anyone of the problems in the Natural Language Processing domain.	**(8)**
	(b)	Discuss the architecture of GRU	**(6)**

Teaching Plan

Module 1 : [Text book 1: Chapter 5, Textbook 2: Chapter 2](9 hours)		
1.1	Introduction, Learning algorithms - Supervised, Unsupervised, Reinforcement	1 hour
1.2	Overfitting, Underfitting, Hyperparameters	1 hour
1.3	Validation sets, Estimators -Bias and Variance. Challenges in machine learning.	1 hour
1.4	Simple Linear Regression	1 hour
1.5	Illustration of Linear Regression	1 hour
1.6	Logistic Regression	1 hour
1.7	Illustration of Logistic Regression	1 hour
1.8	Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, ROC, AUC.	1 hour
1.9	Illustrative Examples for performance measures	1 hour
Module 2 : Text book 2, Chapter 1 (8 hours)		
2.1	Introduction to neural networks -Single layer perceptrons	1 hour
2.2	Multi Layer Perceptrons (MLPs), Representation Power of MLPs	1 hour
2.3	Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function	1 hour

2.4	Training MLPs with backpropagation	1 hour
2.5	Illustration of back propagation algorithm	1 hour
2.6	Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems	1 hour
2.7	Difficulties in convergence, Local and spurious Optima, Computational Challenges.	1 hour
2.8	Applications of neural networks	1 hour
Module 3 : Text book 1: Chapter 7, 8, Text book 2, Chapter 3, 4 (10 hours)		
3.1	Introduction to deep learning, Deep feed forward network	1 hour
3.2	Training deep models - Introduction, setup and initialization issues	1 hour
3.3	Solving vanishing and exploding gradient problems	1 hour
3.4	Concepts of optimization, Gradient Descent (GD), GD with momentum.	1 hour
3.5	Nesterov accelerated GD, Stochastic GD.	1 hour
3.6	AdaGrad, RMSProp, Adam.	1 hour
3.7	Concepts of Regularization, L1 and L2 regularization.	1 hour
3.8	Early stopping, Dataset augmentation	1 hour
3.9	Parameter sharing and tying, Injecting noise at input, Ensemble methods	1 hour
3.10	Dropout, Parameter initialization.	1 hour
Module 4 : Text book 1, Chapter 9, Text book 2: Chapter 8 (8 hours)		
4.1	Convolutional Neural Networks, architecture	1 hour
4.2	Convolution and Pooling operation with example	1 hour
4.3	Convolution and Pooling as an infinitely strong prior	1 hour
4.4	Variants of convolution functions, structured outputs, data types	1 hour
4.5	Efficient convolution algorithms.	1 hour
4.6	Practical use cases for CNNs	1 hour
4.7	Case study - Building CNN with MNIST and AlexNet.	1 hour
4.8	Case study - Building CNN with MNIST and AlexNet	1 hour
Module 5 : Text book 1 :Chapter 10, 11, Text book 2:Chapter 7 (10 hours)		

5.1	Recurrent neural networks – Computational graphs, RNN design	1 hour
5.2	Encoder – decoder sequence to sequence architectures	1 hour
5.3	Deep recurrent networks- Architecture	1 hour
5.4	Recursive neural networks	1 hour
5.5	Modern RNNs - LSTM	1 hour
5.6	Modern RNNs - LSTM	1 hour
5.7	GRU	1 hour
5.8	Practical use cases for RNNs.	1 hour
5.9	Case study - Natural Language Processing.	1 hour
5.10	Case study - Natural Language Processing.	1 hour

SEMESTER VI

SCHEME : B.TECH 2019

PROGRAMME : ELECTRONICS AND COMPUTER ENGINEERING

ERT 302	OPERATING SYSTEMS	Category	L	T	P	Credit
		PCC	3	1	0	4

Preamble: Study of operating system is an essential to understand the overall working of computer system, tradeoffs between performance and functionality and the division of jobs between hardware and software. This course introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system. The course helps the learner to understand the fundamentals about any operating system design so that they can extend the features of operating system to detect and solve many problems occurring in operating system and to manage the computer resources appropriately.

Prerequisite: Topics covered in the courses Data Structures (CST 201) and Programmingin C (EST 102)

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

CO1	Explain the relevance, structure and functions of Operating Systems in computing devices. (**Cognitive knowledge: Understand**)
CO2	Illustrate the concepts of process management and process scheduling mechanisms employed in Operating Systems. (**Cognitive knowledge: Understand**)
CO3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors (**Cognitive knowledge: Understand**)
CO4	Explain any one method for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems. (**Cognitive knowledge: Understand**)
CO5	Explain the memory management algorithms in Operating Systems. (**Cognitive knowledge: Understand**)
CO6	Explain the security aspects and algorithms for file and storage management in Operating Systems. **(Cognitive knowledge: Understand)**

Mapping of course outcomes with program outcomes

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

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	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module I

Introduction: Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules – System boot process.

Module II

Processes - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems, Message passing systems.

Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job First, Priority scheduling, Round robin scheduling.

Module III

Process synchronization- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Monitors – Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.

Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.

Module IV

Memory Management: Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.

Module V

File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods.
Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.

Text Book

Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 'Operating System Concepts' 9th Edition, Wiley India 2015.

Reference Books:

1. Andrew S Tanenbaum, "Modern Operating Systems" , 4th Edition, Prentice Hall, 2015.
2. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", 3rd Edition, Pearson Education.
4. D.M.Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.
5. Sibsankar Haldar, Alex A Aravind, "Operating Systems", Pearson Education.

Sample Course Level Assessment Questions

Course Outcome1 (CO1): What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture?

Course Outcome 2 (CO2): Define process. With the help of a neat diagram explain different states of process.

Course Outcome 3 (CO3): What do you mean by binary semaphore and counting semaphore? With C, explain implementation of wait () and signal ().

Course Outcome 4 (CO4): Describe resource allocation graph for the following. a) with a deadlock b) with a cycle but no deadlock.

Course Outcome 5 (CO5): Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4-page frames, using the following page replacement algorithms. i) LRU ii) FIFO iii) Optimal

Course Outcome 6 (CO6): Explain the different file allocation methods with advantages and disadvantages.

Model Question Paper

QP CODE: PAGES: ___

Reg No:________________
Name:__________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 302

Course name: OPERATING SYSTEMS

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. How does hardware find the Operating System kernel after system switch-on?

2. What is the purpose of system call in operating system?

3. Why is context switching considered as an overhead to the system?

4. How is inter process communication implement using shared memory?

5. Describe resource allocation graph for the following.

    a. with a deadlock   b. with a cycle but no deadlock.

6. What is critical section? What requirement should be satisfied by a solution to the critical section problem?

7. Consider the reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults occur while using FCFS for the following cases.

    a. frame=2   b. frame=3

1. Differentiate between internal and external fragmentations.

2. Compare sequential access and direct access methods of storage devices.

3. Define the terms (i) Disk bandwidth (ii) Seek time.

PART-B (Answer any one question from each module)

4. a) Explain the following structures of operating system (i) Monolithic systems (ii) Layered Systems (iii) Micro Kernel (iv) Modular approach. **(12)**

   b) Under what circumstances would a user be better of using a time-sharing system than a PC or a single user workstation? **(2)**

OR

5. a) What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture? **(8)**

   b) Describe the differences between symmetric and asymmetric multiprocessing? What are the advantages and disadvantages of multiprocessor systems? **(6)**

6. a) Define process. With the help of a neat diagram explain different states of process. **(8)**

   b) Explain how a new process can be created in Unix using fork system call. **(6)**

OR

7. a) Find the average waiting time and average turnaround time for the processes given in thetable below using:- i) SRT scheduling algorithm ii) Priority scheduling algorithm **(9)**

Process	Arrival Time (ms)	CPU Burst Time (ms)	Priority
P1	0	5	3
P2	2	4	1
P3	3	1	2
P4	5	2	4

b) What is a Process Control Block? Explain the fields used in a Process Control Block. **(5)**

8. Consider a system with five processes P_0 through P_4 and three resources of type A, B, C. Resource type A has 10 instances, B has 5 instances and C has 7 instances. Suppose at time t_0 following snapshot of the system has been taken:

Process	Allocation			Max			Available		
	A	B	C	A	B	C	A	B	C
P_0	0	1	0	7	5	3	3	3	2
P_1	2	0	0	3	2	2			
P_2	3	0	2	9	0	2			
P_3	2	1	1	2	2	2			
P_4	0	0	2	4	3	3			

i) What will be the content of the Need matrix? Is the system in a safe state? If Yes, then what is the safe sequence? **(8)**

iii) What will happen if process P_1 requests one additional instance of resource type A and two instances of resource type C? **(6)**

OR

9. a) State dining philosopher's problem and give a solution using semaphores. **(7)**

b) What do you mean by binary semaphore and counting semaphore? With C struct, explain implementation of wait () and signal() **(7)**

10. a) Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4-page frames, using the following page replacement algorithms i) LRU ii) FIFO iii) Optimal **(9)**

b) Explain the steps involved in handling a page fault. **(5)**

OR

11. a) With a diagram, explain how paging is done with TLB. **(5)**

b) Memory partitions of sizes 100 kb, 500 kb, 200 kb, 300 kb, 600 kb are available, how would best, worst and first fit algorithms place processes of size 212 kb, 417 kb, 112 kb, 426 kb in order. Rank the algorithms in terms of how efficiently they use memory. **(9)**

12. a) Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. the drive currently services a request at cylinder 143, and the previous request was at cylinder 125. the queue of pending request in FIFO order is 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. Starting from the current position, what is the total distance (in cylinders) that the disk arm moves to satisfy all pending requests for each of the following algorithms

1. FCFS ii) SSFT iii) SCAN iv) LOOK v) C-SCAN **(10)**

b) What is the use of access matrix in protection mechanism? **(4)**

OR

13. a) Explain the different file allocation operations with advantages and disadvantages. **(8)**

b) Explain the following i) file types ii) file operation iii) file attributes **(6)**

Teaching Plan

	Module 1 - Introduction	**5 Hours**
1.1	Introduction to Operating System	1
1.2	Operating System operations, functions, service	1
1.3	System calls, Types	1
1.4	Operating System Structure: Simple, Layered, Microkernel, Modules	1
1.5	System Boot Process	1
	Module 2 – Processes and Process Scheduling	**9 Hours**
2.1	Processes, Process states	1
2.2	Process Control Block, Threads	1

2.3	Scheduling	1
2.4	Operations on processes: process creation and termination	1
2.5	Inter-process communication: Shared memory systems, Message Passing	1
2.6	Process Scheduling – Basic concepts, Scheduling Criteria	1
2.7	Scheduling algorithms - Basics	1
2.8	First come First Served, Shortest Job First	1
2.9	Priority scheduling, Round Robin Scheduling	1
	Module 3 - Process synchronization and Dead locks	**13 Hours**
3.1	Process synchronization, Race conditions	1
3.2	Critical Section problem, Peterson's solution	1
3.3	Synchronization hardware, Mutex Locks	1
3.4	Semaphores	1
3.5	Monitors	1
3.6	Synchronization problem examples (Lecture 1)	1
3.7	Synchronization problem examples (Lecture 2)	1
3.8	Deadlocks: Necessary conditions, Resource Allocation Graphs	1
3.9	Deadlock prevention	1
3.10	Deadlock avoidance	1
3.11	Banker's algorithm	1
3.12	Deadlock detection	1
3.13	Deadlock recovery	1
	Module 4 - Memory Management	**9 Hours**
4.1	Memory Management: Concept of Address spaces	1
4.2	Swapping	1
4.3	Contiguous memory allocation, fixed and variable partitions	1
4.4	Segmentation.	1
4.5	Paging (Lecture 1)	1
4.6	Paging (Lecture 2)	1
4.7	Virtual memory, Demand Paging	1

4.8	Page replacement algorithms (Lecture 1)	1
4.9	Page replacement algorithms (Lecture 2)	1
	Module 5 - File and Disk management	**9 Hours**
5.1	File concept, Attributes, Operations, types, structure	1
5.2	Access methods	1
5.3	Protection	1
5.4	File-System implementation	1
5.5	Directory implementation	1
5.6	Allocation methods	1
5.7	Magnetic disks, Solid-state disks, Disk structure	1
5.8	Disk scheduling	1
5.9	Disk formatting	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT 304	**EMBEDDED SYSTEMS & IoT**	PCC	3	1	0	4

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

CO 1	Understand the basics of embedded systems, IoT and networking. **(Cognitive knowledge level: Understand)**
CO 2	Illustrate various sensors and actuators for embedded systems and IoT. **(Cognitive knowledge level: Understand)**
CO 3	Comprehend the underlying principles and concepts behind IoT design considerations. **(Cognitive knowledge level: Understand)**
CO 4	Apply the understanding of IoT requirements and constraints to select suitable connectivity and communication technologies for specific IoT applications. **(Cognitive knowledge level: Apply)**
CO 5	Model Interfacing of sensors and actuators with development boards **(Cognitive knowledge level: Apply)**
CO 6	Illustrate various IoT physical servers and cloud offerings. **(Cognitive knowledge level: 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	✔											✔
CO 2	✔				✔							✔
CO 3	✔				✔							✔
CO 4	✔		✔	✔	✔							✔
CO 5	✔		✔									✔
CO 6	✔											✔

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 complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	50
Apply	20	20	40
Analyze	-	-	-
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. How are PANs different from LANs?
2. Differentiate between microprocessor and microcontroller
3. Write short notes on evolution of IoT

Course Outcome 2 (CO2):

1. What are the main features of shape memory polymers?
2. What are the critical factors to be considered during the design of IoT devices?
3. Explain any 3 Sensor Characteristics

Course Outcome 3 (CO3):

1. What is service discovery protocol (SDP) in Bluetooth?
2. Describe the HART data link layer.
3. What is QUIC? How is the connection latency reduced in QUIC?

Course Outcome 4 (CO4):

1. Modify or Write New Program to make GPIO2 LED blinking.
2. Problem: You want to use an Arduino with multiple sensors built in
   Write a program to find solution to this problem using Arduino
3. Write a program for controlling the lock from the cloud using NodeMCU

Course Outcome 5 (CO5):

1. Write short notes on "Evolution of New IoT Paradigms"
2. Write the various steps for Setting up Raspberry Pi by installing OS and obtaining static IP of Raspberry Pi.
3. What are Amazon Web Services (AWS)? Explain the significance.

SYLLABUS

Module 1: Introduction to Embedded Systems and IoT

Application domain of Embedded systems: Desirable features and general characteristics of Embedded Systems - Model of Embedded systems - Microcontroller Vs Microprocessors.

Introduction of IoT: Evolution of IoT - Enabling IoT and the Complex Interdependence of Technologies - IoT Networking Components - Addressing Strategies in IoT.

Basics of Networking: Network Types - Layered Network Models - Addressing - TCP/IP Transport layer.

Module 2: Embedded systems & IoT- Sensors and Actuators

Sensors: Sensor Characteristics - Sensorial Deviations - Sensing Types - Sensing Considerations
Actuators: Actuator Types - Actuator Characteristics
IoT Processing Topologies and Types: Data Format - Importance of Processing in IoT - Processing Topologies - IoT Device Design and Selection Considerations - Processing Offloading

Module 3: IoT connectivity and communication technologies

IoT Connectivity Technologies: IEEE 802.15.4 - Zigbee - ISA100.11A - Wireless HART - RFID - NFC - Z-Wave - Weightless - LoRa - NB-IoT - Wi-Fi - Bluetooth

IoT Communication Technologies: Introduction - Infrastructure Protocols - Discovery Protocols - Data Protocols - Identification Protocols - Device Management - Semantic Protocols

Module 4: Arduino and NodeMCU

Introduction to the Arduino platform: Hardware features of Arduino - Arduino IDE - Simple programs of Arduino using C++ - LED, switch and LCD interfacing with Arduino.
Understanding the NodeMCU platform: Hardware features of NodeMCU - Programming NodeMCU with Arduino IDE - Interfacing any sensor and actuator with NodeMCU.

Module 5: Raspberry pi and Developing IoT applications

Introduction to Raspberry Pi: Raspberry Pi hardware details - installing OS in Raspberry Pi - Preparing python program to interface any one sensor and actuator using GPIO pins of Raspberry Pi.
Overview of IoT physical servers and cloud offerings: Amazon Web Services (AWS) IoT platform - Microsoft Azure IoT - Blynk (Introduction only for all topics here).
Challenges Associated with IoT: Evolution of New IoT Paradigms.

Textbooks:

1. "Introduction to IoT" by Sudip Misra, Anandarup Mukherjee, Arijit Roy, Cambridge University Press, First edition, 2021, ISBN 9781108842952, ISBN 9781108959742
2. "Arduino Cookbook: Recipes to Begin, Expand, and Enhance Your Projects" by Michael Margolis, 3rd edition, 2020, O'Reilly Media, ISBN: 9781491903520

References:

1. "Internet Of Things with Raspberry Pi and Arduino" by Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain, CRC press, 1st Edition, ISBN:9780367248215
2. "NodeMCU ESP8266 Communication Methods and Protocols - Programming with Arduino IDE", Manoj R. Thakur, Amazon Media EU S.à r.l. (2018)
3. "Internet of Things - A Hands-On approach" - Arshdeep Bahga, Vijay Madisetti - Universities Press (India) Private Limited (2015)
4. "Embedded Systems – An Integrated approach" by Lyla P Das, Pearson
5. https://docs.aws.amazon.com/whitepapers/latest/aws-overview/introduction.html
6. https://azure.microsoft.com/en-us/explore
7. https://docs.blynk.io/en/

Model Question Paper

Reg No: **Name:**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR
Course Code: ERT304

Course Name: EMBEDDED SYSTEMS & IoT

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. Differentiate between point-to-point and point-to-multipoint connection types.
2. Differentiate between IoT and M2M.
3. How is sensor resolution different from its accuracy?
4. What are the different data formats found in IoT network traffic streams?
5. Differentiate between star and mesh network topologies.
6. Describe the LOADng protocol.
7. Write a program to print “hello, world!” on an LCD display using Arduino
8. Draw a diagram for Connecting a light-dependent resistor to an Arduino
9. What are the various common hardware features of Raspberry Pi hardware?
10. State a few challenges associated with IoT

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. Discuss the layered architecture of IoT (14)

OR

12. a) Discuss the pros and cons of the following network topologies: (7)
    (i) Star (ii) Ring (iii) Bus (iv) Mesh
    b) “A PC is not considered as an embedded system”. Justify. (7)

Module2

13. Write short notes on Processing Offloading (14)

OR

14. Briefly explain the following types of actuators (14)

(i) Hydraulic (ii) pneumatic (iii) electrical (iv) thermal/magnetic

Module3

15. What is a scatternet? Explain the working of a scatternet with a brief description of its various members. (14)

OR

16. Write short notes on Identification Protocols (14)

Module-4

17. Problem: You want to detect when something is moved, tilted, or shaken. Write a program to find solution to this problem using Arduino (14)

OR

18. Implement temperature control system by controlling a fan, if the temperature exceeds a limit. (Use arduino as control board) (14)

Module 5

19. Briefly explain the following: (14)
    i. Amazon Web Services (AWS) IoT platform
    ii. Microsoft Azure IoT
    iii. Blynk

OR

20. Write a program to Light an LED by reading status of a switch connected to GPIO of the Raspberry Pi board. (14)

Course Contents and Lecture Schedule:

No	Topic	Hours (45)
1	**Module 1: Introduction to Embedded Systems and IoT**	**(8 hours)**
1.1	**Application domain of Embedded systems**: Desirable features and general characteristics of Embedded Systems	1
1.2	Model of Embedded systems - Microcontroller Vs Microprocessors	1
1.3	**Introduction of IoT:** Evolution of IoT- Enabling IoT and the Complex Interdependence of Technologies	1
1.4	IoT Networking Components	1
1.5	Addressing Strategies in IoT	1
1.6	**Basics of Networking**: Network Types	1
1.7	Layered Network Models	1
1.8	Addressing - TCP/IP Transport layer	1

2	**Module 2: Embedded systems & IoT- Sensors and Actuators**	**(8 hours)**
2.1	**Sensors:** Sensor Characteristics - Sensorial Deviations	1
2.2	Sensing Types - Sensing Considerations	1
2.3	**Actuators:** Actuator Types	1
2.4	Actuator Characteristics	1
2.5	**IoT Processing Topologies and Types:** Data Format- Importance of Processing in IoT	1
2.6	Processing Topologies	1
2.7	IoT Device Design and Selection Considerations	1
2.8	Processing Offloading	1
3	**Module 3: IoT connectivity and communication technologies**	**(10 hours)**
3.1	**IoT Connectivity Technologies:** IEEE 802.15.4 - Zigbee	1
3.2	ISA100.11A - Wireless HART	1
3.3	RFID – NFC	1
3.4	Z-Wave - Weightless	1
3.5	LoRa - NB-IoT	1
3.6	Wi-Fi – Bluetooth	1
3.7	**IoT Communication Technologies:** Introduction - Infrastructure Protocols	1
3.8	Discovery Protocols - Data Protocols	1
3.9	Identification Protocols	1
3.10	Device Management - Semantic Protocols	1
4	**Module 4: Arduino and NodeMCU**	**(11 hours)**
4.1	**Introduction to the Arduino platform:** Hardware features of Arduino	1
4.2	Arduino IDE	1
4.3	Simple programs of Arduino using C++	1
4.4	LED interfacing with Arduino	1
4.5	switch interfacing with Arduino	1
4.6	LCD interfacing with Arduino	1
4.7	**Understanding the NodeMCU platform:** Hardware features of	1

	NodeMCU	
4.8	Programming NodeMCU with Arduino IDE (Lecture 1)	1
4.9	Programming NodeMCU with Arduino IDE (Lecture 2)	1
4.10	Interfacing any sensor and actuator with NodeMCU (Lecture 1)	1
4.11	Interfacing any sensor and actuator with NodeMCU (Lecture 2)	1
5	**Introduction to Raspberry Pi**	**(8 hours)**
5.1	Raspberry Pi hardware details - installing OS in Raspberry Pi	1
5.2	Preparing python program to interface any one sensor and actuator using GPIO pins of Raspberry Pi. (Lecture 1)	1
5.3	Preparing python program to interface any one sensor and actuator using GPIO pins of Raspberry Pi. (Lecture 2)	1
5.4	**Overview of IoT physical servers and cloud offerings**	1
5.5	Amazon Web Services (AWS) IoT platform	1
5.6	Microsoft Azure IoT	1
5.7	Blynk (Introduction only for all topics here).	1
5.8	**Challenges Associated with IoT:** Evolution of New IoT Paradigms	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT 306	**DATA COMMUNICATION AND NETWORKING**	**PCC**	**3**	**1**	**0**	**4**

Prerequisite: Fundamentals of TCP/IP protocol and its layer model, operating systems, computer networks

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

CO 1	Understand data communication and networking using the layered concept, Open System Interconnect (OSI) and the TCP/IP Model. **(Cognitive Knowledge: Understand)**
CO 2	Illustrate various types of encoding techniques and error detection methods used in networks. **(Cognitive Knowledge: Understand)**
CO 3	Use the concept of multiplexing, switching and routing in networks. **(Cognitive Knowledge: Apply)**
CO 4	Discuss the working principles of LAN and the concepts behind congestion in networks. **(Cognitive Knowledge: Understand)**
CO 5	Recognize the principles and operations of internetworking and various protocols used. **(Cognitive Knowledge: 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	✓	✓	✓	✓								✓
CO 2	✓	✓	✓									✓
CO 3	✓	✓	✓	✓								✓
CO 4	✓	✓	✓									✓
CO 5	✓	✓	✓	✓								✓

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 complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance

PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
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. Give the relevance of OSI model in data communication and networking.
2. Explain analog, digital and wireless transmission.

Course Outcome 2 (CO2):

1. Explain different encoding techniques
2. Study various error detection and correction methods

Course Outcome 3 (CO3):

1. Explain different multiplexing methods
2. Explain various switching techniques
3. What is shortest path routing algorithm in computer networks example?

Course Outcome 4 (CO4):

1. List various types of congestion control methods
2. Explain various LAN architecture

Course Outcome 5 (CO5):

1. Discuss the protocols used for internetworking
2. Explain the routing protocols

SYLLABUS

MODULE 1: Data communication and networking overview

A data communication model-data communication - data communications networking - protocol architecture - the need for a protocol architecture - a simple protocol architecture - OSI – TCP/IP protocol architecture. Data transmission - Concepts and terminology - Analog and Digital data transmission-Transmission Impairments – channel capacity - Guided and Wireless transmission – guided transmission media – wireless transmission – wireless propagation.

MODULE 2: Signal encoding and Digital data communication techniques

Digital data, Digital signals & analog signals – analog data, digital signals and analog signals. Asynchronous and synchronous transmission -Types of Error -Error Detection -Error Correction-Line configuration- Interfacing. Data link Control -Flow control-Error Control-HDLC.

MODULE 3: Multiplexing

FDM – Synchronous TDM – statistical TDM – Asymmetric DSL – xDSL. Circuit Switching and packet switching: switching networks - circuit switching networks - circuit switching concepts - control signaling - soft switch architecture-Packet switching principles-X.25-Frame Relay.
Routing in Switched Networks: routing in circuit switched network – routing in packet switched network – least cost algorithms.

MODULE 4: Congestion control in switched Data network

Effect of congestion - Congestion control - Traffic management - Congestion control in packet switching networks - Frame Relay congestion control.
Local Area Network: Background – Topologies and transmission media – LAN protocol architecture – bridges – layer2 and layer3 switches. High speed LANs: the emergence of High-speed LAN's – Ethernet – token ring – fibre channel.

MODULE 5: Internetwork protocols

Basic protocol functions – principles of internetworking – connectionless operation – Internet Protocol operation: multicasting – routing protocols – integrated services architecture – differentiated services. Transport protocol: connection-oriented transport protocol machanisms - TCP – TCP – congestion control - UDP.

Text Book:

1. William Stallings, Data and Computer Communication, Eighth Edition.

Reference Book:

2. Behrouz A. Forouzan, Data Communications and Networking, Second Edition, Tata McGraw-Hill.

Model Question Paper

Reg No.: Name:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR
Course Code: ERT 306

Course Name: DATA COMMUNICATION AND NETWORKING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What are the Functions of Transport, Network and Data Link Layer?
2. What do you mean by Mobile Station Subsystem? Explain?
3. What are the techniques can be employed to encode the data stream when transmitting a digital signal in digital form over a network?
4. What are the various types of error-detection methods?
5. Why does computer network need multiplexing?
6. Which routing strategies are used in packet switched network explain?
7. Which congestion control techniques try to reduce congestion after it happens in the network?
8. What are the 4 types of LAN?
9. How many types of Internet protocols are there?
10. Why TCP is called end-to-end protocol?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. Define OSI layers**,** Are there any alternative models to the OSI model? If yes, define it. (14 marks)
12. (A)What key factors affect channel capacity? How the channel capacity can be calculated? (7 marks)

(B) What is the significance of propagation model in wireless communication?

(7 Marks)

Module2

13. (A) Why is synchronous transmission typically more efficient than asynchronous transmission? (7 marks)

    (B) What are the 3 types of stations in HDLC? explain (7 Marks)

14. Which sublayer of the data link layer performs data link functions that depend upon the type of medium? Explain. (14 Marks)

Module 3

15. What's the difference between a circuit switched and a packet switched network? (14 Marks)

16. How does routing work? What is the difference between default route and default gateway. (14 Marks)

Module 4

17. What is it goal of congestion control? How the congestion is controlled in packet switched networks? (14 Marks)

18. (A)What is the difference between layer 2 and layer 3 of the OSI model? (8 marks)

    (B)What does an Ethernet frame consist of? (6 marks)

Module5

19. Compare distance vector routing protocol and link state routing protocols. (14 marks)

20. What are the two groups of multicast routing protocols? Explain (14 marks)

Course Contents and Lecture Schedule

No	Topic	Hours (45)
1	**Data communication and networking overview**	**10**
1.1	A communication model-data communication-data communication networking	1
1.2	protocol architecture-the need for a protocol architecture	1
1.3	A simple protocol architecture - OSI – TCP/IP protocol architecture	1
1.4	Data transmission-Concepts and terminology	1
1.5	Analog and Digital data transmission	1
1.6	Transmission Impairments	1

1.7	channel capacity	1
1.8	Guided and Wireless transmission	1
1.9	Guided transmission media	1
1.10	wireless transmission – wireless propagation.	1
2	**Signal encoding techniques**	**8**
2.1	Digital data, Digital signals.	1
2.2	Digital data, analog signals.	1
2.3	Analog data digital signal and analog signals.	1
2.4	Digital data communication techniques: Asynchronous and synchronous transmission – lecture 1	1
2.5	Digital data communication techniques: Asynchronous and synchronous transmission – lecture 2	1
2.6	Types of Error -Error Detection.	1
2.7	Error Correction - Line configuration.	1
2.8	Data link Control -Flow control-Error Control-HDLC.	1
3	**Multiplexing**	**10**
3.1	FDM	1
3.2	Synchronous TDM – statistical TDM	1
3.3	Asymmetric DSL	1
3.4	xDSL	1
3.5	Circuit Switching and packet switching: switching networks -	1
3.6	circuit switching networks - circuit switching concepts	1
3.7	Control signaling - soft switch architecture	1
3.8	Packet switching principles-X.25-Frame Relay.	1
3.9	Routing in Switched Networks: routing in circuit switched network	1
3.10	routing in packet switched network – least cost algorithms.	1
4	**Congestion control in switched Data network**	**8**
4.1	Effect of congestion - Congestion control – Lecture 1	1
4.2	Effect of congestion - Congestion control – Lecture 2	1

4.3	Traffic management - Congestion control in packet switching networks	1
4.4	Frame Relay congestion control.	1
4.5	Local Area Network: Background – Topologies and transmission media – LAN protocol architecture	1
4.6	layer2 and layer3 switches.	1
4.7	High speed LANs: the emergence of High-speed LAN's – Ethernet	1
4.8	token ring – fibre channel.	1
5	**Internetwork protocols**	**9**
5.1	Basic protocol functions – principles of internetworking –	1
5.2	Connectionless internetworking – Internet Protocol.	1
5.3	Internet work operation: multicasting – routing protocols	1
5.4	integrated services architecture – Lecture 1	1
5.5	integrated services architecture– Lecture 2	1
5.6	integrated services architecture– Lecture 3	1
5.7	differentiated services	1
5.8	Transport protocol: connection – oriented TCP – TCP – Congestion control	1
5.9	UDP.	1

SEMESTER VI

PROGRAM ELECTIVE I

ERT 312	SENSORS & ACTUATORS	Category	L	T	P	Credits
		PEC	2	1	0	3

Preamble: Sensors and actuators play a vital role in manufacturing, machinery, aerospace, medicine and robotics. Most of the advancements of present day would be not possible without sensors. The main purpose of offering this course is to elaborate the theoretical and practical aspects of sensors and actuators, their classifications, recent trends and their applications in day today life.

Prerequisite: Nil

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

CO1	Get an exposure to sensors and actuators and its importance in the real world. **(Cognitive Knowledge Level: Understand)**
CO2	Explain the working of magnetic sensors and its applications in real time scenario. **(Cognitive Knowledge Level: Understand)**
CO3	Model linear actuators and differentiate various solenoids. **(Cognitive Knowledge Level: Apply)**
CO4	Explain the working principle of different types of rotary actuators. **(Cognitive Knowledge Level: Understand)**
CO5	Understand the basic idea on the controls in NC machine and fluidic system. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔						✔			
CO2	✔	✔	✔						✔			
CO3	✔	✔	✔						✔			
CO4	✔	✔	✔						✔			
CO5	✔	✔	✔						✔			

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Introduction

Introduction- Classification of Sensors and Actuators - Magnetic Sensors - Linear and Latching Solenoid Actuators - Stepper Motors - Special Magnetic Devices - Rotary and Linear Actuators - Magnetic Materials and Technology - Soft Magnetic Materials – Hard Magnetic Materials - Coating Technologies - Magnetic Materials Market and Applications

Module-2: Magnetic Sensors

Magnetic Sensors - Theory of Magnetic Sensors - Magnetic Sensor Analysis – VR Sensors - Solid-State Sensors - Magnetic Sensor Applications - Magnetic Speed Sensor Requirements - Magnetic Speed Sensor Applications - Magnetic Position Sensor Applications - VR Sensor Noise

Module-3: Linear Actuators

Linear Actuators - Mathematical Model for Linear Actuators - Fast-Acting Actuators - Disk Solenoids - Plunger Solenoids - Ball Solenoids - Conical Solenoids - Applications of Solenoid Actuators - Long Stroke Solenoid Fuel Pump - Gasoline Injectors - Natural Gas Injectors - Diesel Fuel Injectors - Compressor Solenoid Valves - Transmission Solenoids

Module-4: Rotary Actuators

Rotary Actuators - Disk Rotary Actuators - Disk Rotary Actuator Analysis – Disk Rotary Actuator Design - Disk Rotary Actuator Excitation Electromagnetic Circuit – Disk Rotary Actuator Toothed Magnetic Part - Disk Rotary Actuator PM - Claw Pole Rotary Actuators -

Claw Pole Rotary Actuator Analysis - Claw Pole Rotary Actuator Design -Claw Pole Rotary Actuator Excitation Electromagnetic Circuit - Claw Pole Actuator Toothed Magnetic Part - Claw Pole Actuator PM - Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation Electromagnetic Circuit – Cylindrical Rotary Actuator Toothed Magnetic Structure - Rotary Actuator Applications - Disk Rotary Actuator Application - Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator Application

Module-5: Controls in NC Machines and fluidic control

Controls in NC Machines and fluidic control- stepping motors- feedback devices-encoders - resolvers - induct sync –Tach generators - principles of fluid logic control - Coanda effect - basic fluidic devices - fluidic logic gates - bistable flipflop - OR and NOR gates - exclusive OR gates - fluidic sensors - backpressure sensor - cone jet proximity sensor - interruptible jet sensor.

Text Books

1. Andrzej M. Pawlak, "Sensors and Actuators in Mechatronics, Design and Applications", Taylor & Francis Group, 2006

References

1. Andrew Parr, "Hydraulics and Pneumatics ", Jaico Publishing House, Mumbai
2. Yoram Koren, 'Computer control of Manufacturing Systems', Tata Mc. Graw Hill Publishers, New Delhi
3. Robert H. Bishop, "Mechatronic systems, Sensors and Actuators Fundamentals and Modelling, Taylor & Francis Group, 2007.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What do you mean by an actuator?
2. Compare Soft Magnetic and Hard Magnetic Materials with suitable example.
3. Identify any 3 applications of Rotary and Linear Actuators in the present scenario.

Course Outcome 2 (CO2)

1. What are the requirements of Magnetic Speed Sensors?
2. Explain Solid-State Sensors with neat sketches.
3. Select any 5 applications of Magnetic Position Sensor.

Course Outcome 3(CO3):

1. What are the applications of Solenoid Actuators?
2. Compare Disk Solenoids and Plunger Solenoids.
3. Construct a mathematical model for a linear actuator

Course Outcome 4 (CO4):

1. List the applications of Disk Rotary Actuator.
2. Explain about Claw Pole Rotary Actuator with necessary sketches.
3. Identify the various applications of Cylindrical Rotary Actuator in the field of mechatronics.

Course Outcome 5 (CO5):

1. Define Coanda effect.
2. Explain about basic fluidic devices.
3. Select the applications of fluidic sensors.

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 312
Course Name: SENSORS & ACTUATORS

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

PART A
(Answer All Questions. Each question carries 3 marks)

1.	What is the difference between a sensor and actuators?	**(3)**
2.	Why stepper motors are widely used in Robotic applications?	**(3)**
3.	What are the applications of Magnetic Speed Sensors?	**(3)**
4.	What do you mean by Solid-State Sensors?	**(3)**
5.	What are the applications of Solenoid Actuators?	**(3)**
6.	Define linear actuator with an example.	**(3)**
7.	List the applications of Claw Pole Rotary Actuator.	**(3)**
8.	What do you mean by Rotary actuator?	**(3)**

9.	Define Coanda effect.		**(3)**
10.	Write a short note on encoders.		**(3)**
	Part B **(Answer any one question from each module. Each question carries 14 Marks)**		
11.		Explain about - Linear and Latching Solenoid Actuators	**(14)**
		OR	
12.		Differentiate between soft and hard magnetic materials with suitable examples.	**(14)**
13.		Explain about VR sensors with suitable sketches.	**(14)**
		OR	
14.		Explain magnetic sensor in detail and identify some of its applications.	**(14)**
15.		Explain the working of Gasoline Injectors with neat sketches.	**(14)**
		OR	
16.		Compare Disk, Plunger and Ball solenoids.	**(14)**
17.		Explain Cylindrical Rotary Actuators with neat sketches.	**(14)**
		OR	
18.		Identify the various applications of Cylindrical Rotary Actuator and Disk Rotary Actuators in the field of mechatronics. Explain the working principle of Disk Rotary Actuators in detail.	**(14)**
19.		Explain the working principle of interruptible jet sensor with necessary sketches. 20. Write short notes on the following: i) Resolver ii) Induct sync	**(14)**
		OR	
20.		Write short notes on the following: i) Resolver ii) Induct sync	**(14)**

TEACHING PLAN

No	Contents	Hours (35)
	Module-1 Sensors and Actuators (7hrs)	
1.1	Classification of Sensors and Actuators	1
1.2	Magnetic Sensors	1
1.3	Linear and Latching Solenoid Actuators	1
1.4	Stepper Motors - Special Magnetic Devices	1
1.5	Rotary and Linear Actuators	1
1.6	Magnetic Materials and Technology - Soft Magnetic Materials - Hard Magnetic Materials	1
1.7	Coating Technologies - Magnetic Materials Market and Applications	1
	Module-2 Magnetic Sensors (7 hrs)	
2.1	Theory of Magnetic Sensors	1
2.2	Magnetic Sensor Analysis	1
2.3	VR Sensors	1
2.4	Solid-State Sensors	1
2.5	Magnetic Sensor Applications, Magnetic Speed Sensor Requirements	1
2.6	Magnetic Speed Sensor Applications, Magnetic Position Sensor Applications	1
2.7	VR Sensor Noise	1
	Module-3 Linear Actuators (7 hrs)	
3.1	Mathematical Model for Linear Actuators	1
3.2	Fast-Acting Actuators	1
3.3	Disk Solenoids - Plunger Solenoids	1
3.4	Ball Solenoids, Conical Solenoids - Applications of Solenoid Actuators	1

3.5	Long Stroke Solenoid Fuel Pump	1
3.6	Gasoline Injectors, Natural Gas Injectors	1
3.7	Diesel Fuel Injectors - Compressor Solenoid Valves - Transmission Solenoids	1
	Module-4 Rotary Actuators (7 hrs)	
4.1	Disk Rotary Actuators - Disk Rotary Actuator Analysis - Disk Rotary Actuator Design - Disk Rotary Actuator Excitation	1
4.2	Electromagnetic Circuit - Disk Rotary Actuator Toothed Magnetic Part - Disk Rotary Actuator PM	1
4.3	Claw Pole Rotary Actuators - Claw Pole Rotary Actuator Analysis - Claw Pole Rotary Actuator Design -Claw Pole Rotary Actuator	1
4.4	Excitation Electromagnetic Circuit - Claw Pole Actuator Toothed Magnetic Part - Claw Pole Actuator PM	1
4.5	Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation	1
4.6	Electromagnetic Circuit - Cylindrical Rotary Actuator Toothed Magnetic Structure	1
4.7	Rotary Actuator Applications - Disk Rotary Actuator Application Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator Application.	1
	Module-5 Controls in NC Machines and fluidic control (7 hrs)	
5.1	Stepping motors	1
5.2	Feedback devices, encoders, resolvers.	1
5.3	Inductosyn , Tacho generators	1
5.4	Principles of fluid logic control -Coanda effect	1
5.5	Basic fluidic devices, Fluidic logic gates	1
5.6	Bi stable flip flop - OR and NOR gates - exclusive OR gates	1
5.7	Fluidic sensors, Backpressure sensor, Cone jet proximity sensor, Interruptible jet sensor.	1

ERT 322	BIOMEDICAL SIGNAL & TRANSDUCERS	Category	L	T	P	Credits
		PEC	2	1	0	3

Preamble: This course helps the learners to explore various biomedical signals and fundamental measurement techniques using transducers. The course contents will enable the students to understand and design biomedical systems.

Prerequisite: Nil

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

CO1	Understand the Sources and Types of Different Biomedical Signals. **(Cognitive Knowledge Level: Understand)**
CO2	Explain the principle of transducers, classification and the characteristics of different transducers and Biosensors. **(Cognitive Knowledge Level: Understand)**
CO3	Understand the basics of sensors/ transducers and their characteristics. **(Cognitive Knowledge Level: Understand)**
CO4	Describe various temperature and blood flow meter sensors. **(Cognitive Knowledge Level: Understand)**
CO5	Differentiate between sensors used for the measurement of blood pressure and nano sensors. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔										✔
CO3	✔	✔										✔
CO4	✔	✔										✔
CO5	✔	✔										✔

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	20	20	30
Understand	30	30	70
Apply			
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Introduction to Biomedical Signals

Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

Module-2: EEG Signal Processing and Event Detection in Biomedical Signals

EEG Signal and Its Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis and Coherence Analysis of EEG Channels.

Module-3: Structure of the measurement system

General Structure of the measurement system, Difference between Sensor and Transducer, Classification of Transducer, Static Characteristics, Dynamic Characteristics, Determination of Absolute Quantity. Introduction to biosensor classification based on bio recognition element.

Module-4: Temperature sensors, blood flow and velocity measurement

Temperature sensors principle of operation- construction details-characteristics of–thermo resistive transducers, - RTD-thermistor, thermoelectric transducers- thermocouple and its cold junction compensation-chemical thermometry-Liquid crystals - Solid liquid transition thermometers. Blood flow and velocity measurement- Electromagnetic blood flowmeter and its types, Ultrasonic blood flowmeters- Doppler shift flow velocity meters

Module-5: Blood Pressure transducer and Nano biosensors

Resistive sensors-Potentiometric-resistive strain gauges, inductive sensors–LVDT- capacitive sensors–hall effect transducers-piezo electric sensors- measurement of blood pressure-sphygmomanometer-Indirect method-based on Korotk off sound, oscillometric method. Nano biosensors-basic concepts, construction of Nano biosensors, Nanomaterials for new bio sensing principles, optical nano biosensors basics and applications of BioMEMS

Text Books

1. Rangayyan, R.M. Biomedical signal analysis (Vol. 33). John Wiley & Sons.
2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill, 2015.
3. Andrewg Webb, Principle of biomedical Instrumentation, Cambridge University Press 2018.

References

1. Tompkins, W.J.. Biomedical digital signal processing. Editorial Prentice Hall, 1993
2. Sörnmo, L. and Laguna, P Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press., 2005.
3. Biomedical Transducers & Instruments, By Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg. CRC Press, 2011.
4. Principles of Measurement & Transduction of Biomedical Variables, By Vera Lucia Da Silveira Nantes Button. Elsevier Inc, 2015
5. Sensors & Transducers, D. Patranabis, Phi Learning Pvt. Ltd., 01-Jan-2003

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List out the Objectives of Biomedical Signal Analysis.
2. Explain the terms action potential and Evoked potential.

Course Outcome 2 (CO2):

1. What is correlation Analysis and Coherence Analysis of EEG Channels.
2. What is Autoregressive Method?

Course Outcome 3 (CO3):

1. List out the differences between sensor and transducer.
2. What are the four classifications of transducers?

Course Outcome 4 (CO4):

1. Explain the principle of thermocouple.
2. What are the two types of thermos resistive transducers?
3. Explain the working of blood flow meters.

Course Outcome 5 (CO5):

1. Explain the principle of resistive, capacitive, inductive transducers.
2. What are the transducers used for measuring blood pressure?
3. Explain the working of Hall effect transducers.

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 322
Course Name: BIOMEDICAL SIGNAL & TRANSDUCERS

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

PART A
(Answer All Questions. Each question carries 3 marks)

1. State two clinical uses of EEG.
2. What are the difficulties in Biomedical Signal Analysis?
3. What do you mean by Spike and Wave rhythm in EEG signals?
4. What are the two most important and common goals of biomedical signal analysis methods?
5. How does the inductive proximity sensor work?

6. Differentiate between capacitive transducer and resistive transducer.

7. What are the two types of thermos resistive transducers?

8. Illustrate the working of sine wave flow meter.

9. What are inductive transducers

10. Write notes on potentiometer.

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. A) Explain in detail about the bioelectric signal which is responsible for the electrical activity of Brain. (7 marks)

B) Discuss about the bioelectric signal which is responsible for the electrical activity of Nerves and muscles of the stomach (7 marks)

OR

12. A) How noise cancelling is done in ECG? explain in detail (8 marks)

B) Explain Event-Related Potentials. (6 marks)

13. A) Explain how automated ECG analysis is carried out. (8 marks)

B) Explain the procedure adopted for modeling of EEG signals. (7 marks)

OR

14. A) What is the principle of a general electrode used in biomedical signals? Explain various electrode used for measurement of EEG signal. (8 marks)

B) With a neat diagram explain various segmentation of ECG signal. (6 marks)

15. Explain the working of Ion selective Field effect transistor. (14 marks)

OR

16. Describe the construction and working of silver–silver chloride electrode. (14 marks)

17. What are temperature transducers. Explain any two temperature transducers with diagram. (14 marks)

OR

18. Explain ultrasonic blood flow meter with diagram. (14 marks)

19. Explain the working of capacitive and piezo electric sensors. (14 marks)

OR

20. What are Nano biosensors. Explain its basic concepts, construction of Nano biosensors. (14 marks)

TEACHING PLAN

No	Contents	No.of Lecture Hrs
Module-1 (Authentication Protocols) (7hrs)		
1.1	Action Potential and Its Generation.	1
1.2	Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG),	1
1.3	Electroencephalogram (EEG), Electromyogram (EMG).	1
1.4	Phonocardiogram (PCG), Electroneurogram (ENG).	1
1.5	Event-Related Potentials (ERPS), Electrogastrogram (EGG).	1
1.6	Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis.	1
1.7	Computer-Aided Diagnosis.	1
Module-2 (E-mail Security) (6 hrs)		
2.1	EEG Signal and Its Characteristics, EEG Analysis.	1
2.2	Linear Prediction Theory, Autoregressive Method, Sleep EEG.	1
2.3	Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG.	1
2.4	EEG Rhythms, Waves and Transients.	1
2.5	Detection of Waves and Transients.	1
2.6	Correlation Analysis Ad Coherence Analysis of EEG Channels.	1
Module-3 (Network Layer Security and Web Security) (8 hrs)		

3.1	General Structure of the measurement system.	1
3.2	Difference between Sensor and Transducer.	1
3.3	Classification of Transducer - Lecture 1	1
3.4	Classification of Transducer - Lecture 2	1
3.5	Static Characteristics,	1
3.6	Dynamic Characteristics,	1
3.7	Determination of Absolute Quantity.	1
3.8	Introduction to biosensor classification based on bio recognition element.	1
Module-4 (Real-time Security and Application Layer Security) (8hrs)		
4.1	Temperature sensors principle of operation- construction details.	1
4.2	Characteristics of–thermo resistive transducers.	1
4.3	RTD-thermistor, thermoelectric transducers.	1
4.4	Thermocouple and its cold junction compensation-chemical thermometry.	1
4.5	Liquid crystals - Solid liquid transition thermometers.	1
4.6	Blood flow and velocity measurement.	1
4.7	Electromagnetic blood flowmeter and its types.	1
4.8	Ultrasonic blood flowmeters- Doppler shift flow velocity meters.	1
Module-5 (System Security and Wireless Security) (6 hrs)		
5.1	Resistive sensors-Potentiometric-resistive strain gauges.	1
5.2	Inductive sensors–LVDT- capacitive sensors–hall effect transducers.	1
5.3	Piezo electric sensors- measurement of blood pressure-sphygmomanometer-Indirect method-based on Korotk off sound.	1
5.4	Oscillometric method. Nano biosensors-basic concepts.	1
5.5	Construction of Nano biosensors, Nanomaterials for new bio sensing principles.	1
5.6	optical nano biosensors basics and applications of BioMEMS.	1

ERT 332	ELECTRONIC PRODUCT DESIGN	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to design and develop of an electronic product that meets the industrial standard.

Prerequisite: EST 200: Design and Engineering

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

CO 1	Understand the electronic product design life cycle and the guidelines of PCB design. **(Cognitive Knowledge Level: Understand)**
CO 2	Familiar with Integrated development Environment and the basic knowledge about EMI/EMC issues in product development **(Cognitive Knowledge Level: Understand)**
CO 3	Familiar with microsystem packaging and the IC assembly **(Cognitive Knowledge Level: Understand)**
CO 4	Understand the thermal considerations in product design and sealing of microsystems. **(Cognitive Knowledge Level: Understand)**
CO5	Apply the PCB design tools and design a new PCB with all design considerations and assembling the different types of PCBs **(Cognitive Knowledge Level: 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	✓	✓										✓
CO 2	✓	✓										✓
CO 3	✓	✓										✓
CO 4	✓	✓										✓
CO 5	✓	✓										✓

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 complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	35	35	60
Apply	K3	5	5	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 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the electronic product design life cycle and the guidelines of PCB design

1. What are the various activities involved in Analysis Phase of EDLC
2. Explain the guidelines for PCB design

Course Outcome 2 (CO2): familiar with Integrated development Environment and the basic knowledge about EMI/EMC issues in product development

1. What is IDE? Explain any one IDE in detail
2. Discuss effect of shielding on EMC

Course Outcome 3 (CO3): familiar with microsystem packaging and the IC assembly

1. With neat diagrams explain wedge bonding in wire bonding IC assembly Technology.
2. Need of microsystem packaging

Course Outcome 4 (CO4): understand the thermal considerations in product design and sealing of microsystems.

1. Why thermal management is necessary in electronic system?
2. Briefly explain Hermetic sealing process.

Course Outcome 5 (CO5): apply the PCB design tools and design a new PCB with all design considerations and assembling the different types of PCBs

1. List out the PCB design guidelines for EM compatibility.
2. Discuss the different board assembly issues

SYLLABUS

Module 1: (7 Hours)

Product Design and Development: Embedded System product Development Life cycle (EDLC), Objectives of EDLC, Phases of EDLC, EDLC approaches (modeling the EDLC): Linear, fountain, Evolutionary and Spiral models. Component selection, Schematic Design, Guidelines for PCB Design, PCB layout, fabrication and assembly

Module 2: (7 Hours)

Embedded System Development Environment–IDE, Cross compilation, Simulators/Emulators, Hardware Debugging: various types, Target hardware debugging. Hardware testing methods like

Boundary Scan, In Circuit Testing (ICT).

EMI/EMC-EMC standards and regulation, grounding, cabling, shielding and guarding (overview only)

Module 3: (6 Hours)

Microsystems Packaging- Need of packaging, electrical, mechanical and material technologies

IC Assembly – Purpose, Requirements, Technologies, Wire bonding, ball bonding and wedge bonding, Tape Automated Bonding, Flip Chip., Wafer Level Packaging.

Module 4: (8 Hours)

Thermal Considerations in Electronic Product Design: Heat generation and modes of heat transfer in Electronic Products- Selection/Design of Heat Sinks- Factors affecting the design of heat sinks and its cooling effectiveness-Assembly of components on heat sinks- Electrical analogue of thermal circuits- Enclosure design of Electronic Equipment's and thermal considerations- Design guidelines for Ventilations- Forced cooling- Heat pipes for electronic cooling applications.

Sealing and Encapsulation: Necessity, Requirements, Encapsulation Processes, Hermetic Sealing

Module 5: (8 Hours)

PCB design: Requirements in PCB Design- PCB Design elements- PCB design process- advantages of PCBs Design rules for analog, digital, high-frequency, power-electronic and MW PCBs-PCB design guidelines for EM compatibility, Single sided PCB, Double sideed PCB, multi-layer PCB (up to 8 layers).

Board Assembly – Surface Mount Technology, Through-Hole Technology, Assembly Issues

Text Books

1. Shibu K.V , Introduction to Embedded Systems, Tata McGraw Hill, 2009
2. Henry.W.Ott, Electromagnetic Compatibility Engineering, Wiley Interscience,2009
3. Rao R. Tummala: Fundamentals of Microsystem Packaging, McGraw Hill
4. R.G.Kaduskar, V.B Baru, Electronic Product Design, Wiley India, 2/e.

Reference books

1. Karl T. Ulrich & Steven D. Eppinger, Product Design and Development, Tata McGraw Hill,
2. Richard K. Ulrich &William D. Brown Advanced Electronic Packaging - 2nd Edition : IEEE Press
3. Charles A Harper, Electronic Packaging and Interconnection Handbook, McGraw hill, Fourth Edition
4. Walter C. Bosshart, Printed Circuit Boards- Design and Technology, Tata McGraw Hill,1988

5. Kevin Otto, Kristin Wood, Product Design- Techniques in Reverse Engineering and NewProduct Development, Pearson Education, (2004)
6. Richard Stillwell, Electronic Product Design for Automated Manufacturing, Marcel DekkerPublications
7. Bert Haskell, Portable Electronics Product Design and Development, McGraw Hill, (2004)

Course Contents and Lecture Schedule

No	Topic	**Hours (36)**
1	**Product Design and Development (7 hrs) (Text Book – 1)**	
1.1	Embedded System product Development Life cycle (EDLC), Objectives of EDLC – Lecture 1	1
1.2	Embedded System product Development Life cycle (EDLC), Objectives of EDLC - Lecture 2	1
1.3	Phases of EDLC	1
1.4	EDLC approaches (modeling the EDLC): Linear, fountain	1
1.5	Evolutionary and Spiral models.	1
1.6	Component selection, Schematic Design	1
1.7	Guidelines for PCB Design, PCB layout, fabrication and assembly	1
2	**Embedded System Development Environment (7 hrs) (Text Books – 1, 2)**	
2.1	IDE, Cross compilation, Simulators/Emulators	1
2.2	Hardware Debugging: various types – Lecture 1	1
2.3	Hardware Debugging: various types – Lecture 2	1
2.4	Target hardware debugging	1
2.5	Hardware testing methods like Boundary Scan, In Circuit Testing (ICT).	1
2.5	**EMI/EMC**-EMC standards and regulation, grounding, cabling, shielding and guarding (overview only) - Lecture 1	1
2.7	**EMI/EMC**-EMC standards and regulation, grounding, cabling, shielding and guarding (overview only) - Lecture 2	1
3	**Microsystems Packaging & IC assembly (6 hrs) (Text Book – 3)**	

3.1	**Microsystems Packaging**- Need of packaging, electrical, mechanical and material technologies - Lecture 1	1
3.2	**Microsystems Packaging**- Need of packaging, electrical, mechanical and material technologies - Lecture 2	1
3.3	**IC Assembly** – Purpose, Requirements, Technologies	1
3.4	Wire bonding, ball bonding and wedge bonding	1
3.5	Tape Automated Bonding, Flip Chip	1
3.6	Wafer Level Packaging.	1
4	**Thermal Considerations in Electronic Product Design (8 hrs) (Text Books – 3, 4)**	
4.1	Heat generation and modes of heat transfer in Electronic Products	1
4.2	Selection/Design of Heat Sinks- Factors affecting the design of heat sinks and its cooling effectiveness	1
4.3	Assembly of components on heat sinks- Electrical analogue of thermal circuits	1
4.4	Enclosure design of Electronic Equipment's and thermal considerations	1
4.5	Design guidelines for Ventilations- Forced cooling-	1
4.6	Heat pipes for electronic cooling applications	1
4.7	**Sealing and Encapsulation**: Necessity, Requirements, Encapsulation Processes	1
4.8	Hermetic Sealing	1
5	**PCB design (8 hrs) (Text Books – 2, 4)**	
5.1	Requirements in PCB Design- PCB Design element	1
5.2	PCB design process - Lecture 1	1
5.3	PCB design process - Lecture 2	1
5.4	Advantages of PCBs Design rules for analog, digital, high-frequency, power-electronic and MW PCBs	1
5.5	PCB design guidelines for EM compatibility, Single sided PCB	1
5.6	Double sided PCB, multi-layer PCB (up to 8 layers),	1
5.7	**Board Assembly** – Surface Mount Technology	1
5.8	Through-Hole Technology, Assembly Issues	1

Assignment:
At least two assignments should be given

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: ERT332

Program: Electronics and Computer Engineering

Course Name: ELECTRONIC PRODUCT DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	What are the various activities involved in Analysis Phase of EDLC	(3)
2	Explain the process of schematic design using EDA tools?	(3)
3	What is In Circuit Emulator (ICE) Based Firmware Debugging	(3)
4	Describe about safety ground.	(3)
5	What you mean by IC assembly? What are the requirements of IC assembly?	(3)
6	Explain the need for packaging	(3)
7	Why thermal management is necessary in electronic system?	(3)
8	What is hermetic sealing? what are the different steps involved in hermetic sealing	(3)
9	List out the PCB design guidelines for EM compatibility.	(3)
10	Discuss the different board assembly issues	(3)

PART – B
Answer one question from each module. Each question carries 14 marks

Module – I

11.a)	Explain the waterfall model of EDLC	8	CO1	K2
11.b)	Explain the guidelines for PCB design	6	CO1	K2

	OR			
12.a)	Explain spiral EDLC model with necessary diagram.	8	CO1	K2
12.b)	Explain the component selection process in PCB design	5	CO1	K2

Module – II

13 a)	Explain the target board debugging in detail.	8	CO2	K2
13 b)	Discuss effect of shielding on EMC	6	CO2	K2
	OR			
14 a)	What are the different tools used for hardware debugging?	8	CO2	K2
14 b)	Discuss in detail about single point ground system.	6	CO2	K2

Module – III

15 a)	With neat diagrams explain Tape Automated Bonding (TAB) Technology	8	CO3	K2
15 b)	Briefly explain the electrical, Mechanical and material technologies of electronic packaging	6	CO3	K2
	OR			
16 a)	With neat diagrams explain wire bonding IC assembly Technology.	8	CO3	K2
16 b)	Consider a television as an example and different levels of microsystem packaging	6	CO3	K2

Module – IV

17 a)	What are the different electronic cooling methods? Explain	8	CO4	K2
17 b)	Briefly explain Hermetic sealing process	6	CO4	K2
	OR			
18 a)	What are the different thermal transport modes in an electronic system? Explain	8	CO4	K2
18 b)	With necessary diagram explain the transfer molding process.	6	CO4	K2

Module – V

19 a)	Apply the knowledge of PCB design and write the steps of designing a 12 V Power supply PCB.	8	CO5	K3
19 b)	Explain the surface mount board assembly	6	CO5	K2
	OR			
20 a)	Apply the knowledge of PCB design and write the steps of designing Inverter PCB .	8	CO5	K3
20 b)	Explain the through hole board assembly	6	CO5	K2

ERT342	GRAPH THEORY	Category	L	T	P	Credit
		PEC	2	1	0	3

Preamble: This course introduces fundamental concepts in Graph Theory, including properties and characterization of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering

Prerequisite: Basic understanding of Discrete Mathematical Structures

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

CO1	Explain vertices and their properties, types of paths, classification of graphs and trees & their properties. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the fundamental theorems on Eulerian and Hamiltonian graphs. **(Cognitive Knowledge Level: Understand)**
CO3	Illustrate the working of Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's algorithm for finding shortest paths. **(Cognitive Knowledge Level: Apply)**
CO4	Explain planar graphs, their properties and an application for planar graphs. **(Cognitive Knowledge Level: Apply)**
CO5	Illustrate how one can represent a graph in a computer. **(Cognitive Knowledge Level: Apply)**
CO6	Explain the Vertex Color problem in graphs and illustrate an example application for vertex coloring. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Internal Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – 1: (Introduction to Graphs)

Introduction- Basic definition – Application of graphs – finite, infinite and bipartite graphs – Incidence and Degree – Isolated vertex, pendant vertex and Null graph. Paths and circuits – Isomorphism, sub graphs, walks, paths and circuits, connected graphs, disconnected graphs and components..

Module – 2: (Eulerian and Hamiltonian graphs)

Euler graphs, Operations on graphs, Hamiltonian paths and circuits, Travelling salesman problem. Directed graphs – types of digraphs, Digraphs and binary relation, Directed paths, Fleury's algorithm

Module – **3**: (**Trees and Graph Algorithms**)

Trees – properties, pendant vertex, Distance and centers in a tree - Rooted and binary trees, counting trees, spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm.

Module – 4: (**Connectivity and Planar Graphs**)

Vertex Connectivity, Edge Connectivity, cut set and Cut Vertices, Fundamental circuits, Planar graphs, Kuratowski's theorem (proof not required), Different representations of planar graphs, Euler's theorem, Geometric dual.

Module – 5: (**Graph Representations and Vertex Coloring**)

Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix. Coloring- Chromatic number, Chromatic polynomial, four color problem and Five color theorem. Greedy coloring algorithm.

Text Books

1. Narsingh Deo, Graph theory, PHI,1979

Reference Books

1. R. Diestel, *Graph Theory,* free online edition, 2016: diestel-graph-theory.com/ basic.html.
2. Douglas B. West, Introduction to Graph Theory, Prentice Hall India Ltd.,2001
3. Robin J. Wilson, Introduction to Graph Theory, Longman Group Ltd.,2010
4. J.A. Bondy and U.S.R. Murty. Graph theory with Applications

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Differentiate a walk, path and circuit in a graph.
2. Is it possible to construct a graph with 12 vertices such that two of the vertices have degree3 and the remaining vertices have degree 4? Justify
3. Prove that a simple graph with n vertices must be connected, if it has more than $\frac{(n-1)(n-2)}{2}$ edges.
4. Prove the statement: If a graph (connected or disconnected) has exactly two odd degrees, then there must be a path joining these two vertices.

Course Outcome 2(CO2):

1. Define Hamiltonian circuit and Euler graph. Give one example for each.
2. Define directed graphs. Differentiate between symmetric digraphs and asymmetric digraphs.
3. Prove that a connected graph G is an Euler graph if all vertices of G are of even degree.

4. Prove that a graph G of n vertices always has a Hamiltonian path if the sum of the degrees of every pair of vertices V_i, V_j in G satisfies the condition $d(V_i)+d(V_j)=n-1$

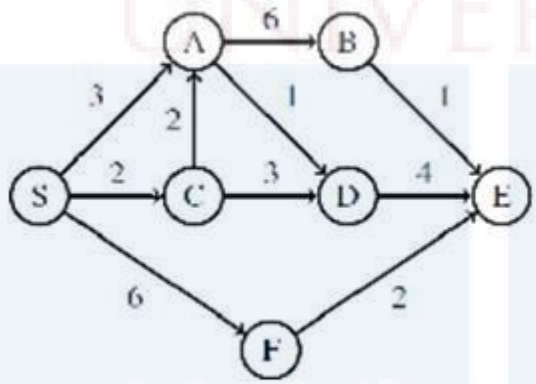
Course Outcome 3(CO3):

i. Discuss the center of a tree with suitable example.

ii. Define binary tree. Then prove that number of pendant vertices in a binary tree is (n+1)/2

iii. Prove that a tree with n vertices has n edges.

iv. Run Dijkstra's algorithm on the following directed graph, starting at vertex ***S***.



Course Outcome 4(CO4): .

1. Define edge connectivity, vertex connectivity and separable graphs. Give an example for each.
2. Prove the statement: Every cut set in a connected graph G must also contain at least one branch of every spanning tree of G.

Course Outcome 5(CO5):

1. Show that if $A(G)$ is an incidence matrix of a connected graph G with n vertices, then rank of $A(G)$ is $n-1$.
2. Show that if B is a cycle matrix of a connected graph G with n vertices and m edges, then rank $B = m-n+1$.
3. Derive the relations between the reduced incidence matrix, the fundamental cycle matrix, and the fundamental cut-set matrix of a graph G.
4. Characterize simple, self-dual graphs in terms of their cycle and cut-set matrices.

Course Outcome 6 (CO6):

1. Show that an n vertex graph is a tree iff its chromatic polynomial is $P_n(\lambda) = \lambda(\lambda-1)^{n-1}$
2. Define Path matrix and Circuit matrix with an example each.

Model Question Paper

QP CODE:

Reg No: _______________

Name:__________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

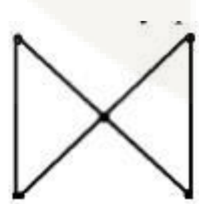
Course Code: ERT342

Course Name: Graph Theory

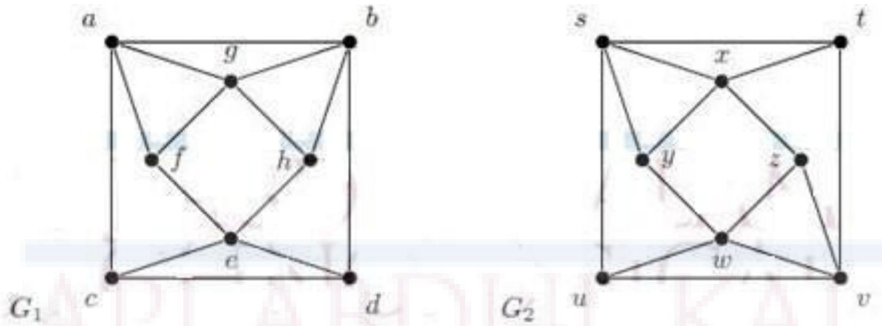
Max. Marks : 100 **Duration: 3 Hours**

PARTA

Answer All Questions. Each Question Carries 3 Marks

1.	Construct a simple graph of 12 vertices with two of them having degree 1, three having degree 3 and the remaining seven having degree10.	**(3)**
2.	What is the largest number of vertices in a graph with 35 edges, if all vertices are of degree at least 3 ?	**(3)**
3.	Define a Euler graph. Give an example of Eulerian graph which is not Hamiltonian	**(3)**
4.	Give an example of a strongly connected simple digraph without a directed Hamiltonian path.	**(3)**
5.	What is the sum of the degrees of any tree of ***n*** vertices?	**(3)**
6.	How many spanning trees are there for the following graph 	**(3)**

7.		Show that in a simple connected planar graph ***G*** having ***V***-vertices, ***E***-edges, and no triangles ***E <= 3V -6***	**(3)**
8.		Let G be the following disconnected planar graph. Draw its dual G*,and the dual of the dual (G*)*.  G	**(3)**
9.		Consider the circuit matrix ***B*** and incidence matrix ***A*** of a simple connected graph whose columns are arranged using the same order of edges. Prove that every row of ***B*** is orthogonal to every row of ***A***?	**(3)**
10.		A graph is *critical* if the removal of any one of its vertices (and the edges adjacent to that vertex) results in a graph with a lower chromatic number. how that ***Kn*** is critical for all ***n > 1***.	**(10x3=30)**
		Part B **(Answer any one question from each module. Each question carries 14 Marks)**	
11.	(a)	Prove that for any simple graph with at least two vertices has two vertices of the same degree.	**(6)**
	(b)	Prove that in a complete graph with ***n*** vertices there are **(n-1)/2** edge disjoint Hamiltonian circuits and ***n >= 3***	**(8)**
		OR	
12.	(a)	Determine whether the following graphs ***G1 = (V1, E1)*** and ***G2 = (V2, E2)*** are isomorphic or not. Give justification.	**(6)**

			
	(b)	Prove that a simple graph with n vertices and k components can have at most(n-k)(n-k+1)/2 edges.	**(8)**
13.	(a)	Let ***S*** be a set of 5 elements.Construct a graph ***G*** whose vertices are subsets of ***S*** of size2 and two such subsets are adjacent in ***G*** if they are disjoint. i) Draw the graph ***G***. ii) How many edges must be added to ***G*** in order for ***G*** to have a Hamiltonian cycle?	**(8)**
	(b)	Let ***G*** be a graph with exactly two connected components, both being Eulerian. What is the minimum number of edges that need to be added to ***G*** to obtain an Eulerian graph?	**(6)**
OR			
14.	(a)	Show that a ***k***-connected graph with no hamiltonian cycle has an independent set of size ***k +1***.	**(8)**
	(b)	i. Let ***G*** be a graph that has exactly two connected components, both being Hamiltonian graphs. Find the minimum number of edges that one needs to add to ***G*** to obtain a Hamiltonian graph. ii. For which values of ***n*** the graph ***Qn*** (hyper-cube on ***n*** vertices) is Eulerian.	**(6)**
15.	(a)	A tree ***T*** has at least one vertex ***v*** of degree 4, and at least one vertex ***w*** of degree 3. Prove that ***T*** has at least 5leaves.	**(5)**
	(b)	Write Dijkstra’s shortest path algorithm. Consider the following weighted directed graph ***G.*** Find the shortest path	**(9)**

		between ***a*** and every other vertices in ***G*** using Dijkstra's shortest path algorithm.	
OR			
16.	(a)	Define pendent vertices in a binary tree? Prove that the number of pendent vertices in a binary tree with ***n*** vertices is ***(n+1)/2***	**(5)**
	(b)	Write Prim's algorithm for finding minimum spanning tree. Find a minimum spanning tree in the following weighted graph, using Prim's algorithm. Determine the number of minimum spanning trees for the given graph.	**(9)**
17.	(a)	1. State and prove Euler's Theorem relating the number of faces, edges andvertices for a planar graph. 2. If ***G*** is a 5-regular simple graph and **|*V*| = 10**, prove that ***G*** is non-planar.	**(9)**
	(b)	Let ***G*** be a connected graph and ***e*** an edge of ***G***. Show that ***e*** is a cut-edge if and only if ***e*** belongs to every spanning tree.	**(5)**
18.	(a)	State Kuratowski's theorem, and use it to show that the graph G below is not planar. Draw G on the plane without edges crossing. Your drawing should use the labeling of the vertices given.	**(9)**
	(b)	Let ***G*** be a connected graph and ***e*** an edge of ***G***. Show that ***e*** belongs to a loop if and only if ***e*** belongs to no spanning tree.	**(5)**
19.	(a)	Define the circuit matrix ***B(G)*** of a connected graph ***G*** with ***n*** vertices and ***e*** edgeswith an example. Prove that the rank of ***B(G)*** is ***e-n+1***	**(7)**
	(b)	Give the definition of the chromatic polynomial ***PG(k)***. Directly from the definition, prove that the chromatic polynomials of ***Wn*** and ***Cn*** satisfy the identity ***PWn(k) = k PCn-1 (k – 1).***	**(7)**
OR			

20.	(a)	Prove that the rank of an incidence matrix of a connected graph with ***n*** vertices is ***n-1.***	**(3)**
	(b)	i. A graph ***G*** has chromatic polynomial ***PG(k) = k4-4k3+5k2-2k***. How many vertices and edges does ***G*** have? Is ***G*** bipartite? Justify your answers. i. State and prove Five Color Theorem.	**(11)**

Teaching Plan

No	**Contents**	**No. of Lecture Hours (36 hrs)**
	Module-1 (Introduction to Graphs) (5 hours)	
1.1	Introduction- Basic definition – Application of graphs – finite and infinite graphs, bipartite graphs,	1 hour
1.2	Incidence and Degree – Isolated vertex, pendent vertex and Null graph,	1 hour
1.3	Paths and circuits, Isomorphism	1 hour
1.4	Sub graphs, walks, Paths and circuits	1 hour
1.5	Connected graphs, Disconnected graphs and components	1 hour
	Module-2 (Eulerian and Hamiltonian graphs) (7 hours)	
2.1	Euler graphs	1 hour
2.2	Operations on graphs	1 hour
2.3	Hamiltonian paths and circuits	1 hour
2.4	Hamiltonian paths and circuits, Travelling salesman problem	1 hour
2.5	Directed graphs – types of digraphs,	1 hour
2.6	Digraphs and binary relation, Directed paths	1 hour
2.7	Fleury’s algorithm	1 hour

Module-3 (Trees and Graph Algorithms) (8 hours)		
3.1	Trees – properties	1 hour
3.2	Trees – properties, pendent vertex	1 hour
3.3	Distance and centers in a tree	1 hour
3.4	Rooted and binary tree	1 hour
3.5	Counting trees	1 hour
3.6	Spanning trees, Fundamental circuits	1 hour
3.7	Prim’s algorithm, Kruskal’s algorithm	1 hour
3.8	Dijkstra’s shortest path algorithm	1 hour
Module-4 (Connectivity and Planar Graphs) (9 hours)		
4.1	Vertex Connectivity, Edge Connectivity	1 hour
4.2	Cut set and Cut Vertices	1 hour
4.3	Fundamental circuits	1 hour
4.4	Fundamental circuits	1 hour
4.5	Planar graphs	1 hour
4.6	Kuratowski’s theorem	1 hour
4.7	Different representations of planar graphs	1 hour
4.8	Euler's theorem	1 hour
4.9	Geometric dual	1 hour
Module-5 (Graph Representations and Vertex Coloring) (7 hours)		
5.1	Matrix representation of graphs- Adjacency matrix, Incidence Matrix	1 hour
5.2	Circuit Matrix, Path Matrix	1 hour
5.3	Coloring- chromatic number,	1 hour
5.4	Chromatic polynomial	1 hour
5.5	Four color problem	1 hour
5.6	Five color Theorem and proof	1 hour
5.7	Greedy coloring algorithm.	1 hour

ERT352	CLOUD COMPUTING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course helps the learners to understand cloud computing concepts. This course includes basic understanding of virtualization, fundamentals of cloud security, cloud computing based programming techniques and different industry popular cloud computing platforms. This course enables the student to suggest cloud-based solutions to real world problems.

Prerequisite: Basic understanding of computer networks and operating systems.

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

CO1	Explain the various cloud computing models and services. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the significance of implementing virtualization techniques. **(Cognitive Knowledge Level: Understand**)
CO3	Explain different cloud enabling technologies and compare private cloud platforms **(Cognitive Knowledge Level: Understand**)
CO4	Apply appropriate cloud programming methods to solve big data problems. (Cognitive Knowledge Level: **Apply**)
CO5	Describe the need for security mechanisms in cloud (**Cognitive Knowledge Level: Understand**)
CO6	Compare the different popular cloud computing platforms **(Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

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

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

Syllabus

Module 1: Fundamental Cloud Computing (7 Hours)

Traditional computing- Limitations. Overview of Computing Paradigms-Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges, Roles and Boundaries. Cloud delivery (service) models-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service(PaaS),Software-as-a-Service (SaaS), XaaS (Anything-as-a-service)-Cloud deployment models- Public cloud, Community cloud, Private cloud, Hybrid cloud.

Module 2: Virtualization (7 Hours)

Introduction to virtualization-Virtualizing physical computing resources, Virtual Machines (Machine virtualization), non-virtualized v/s virtualized machine environments. Types of VMs-process VM v/s system VM, Emulation, interpretation and binary translation. Hardware-level virtualization- Hypervisors/VMM. Types of Hypervisors. Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OS level virtualization. Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization. Case Study- Xen: Para-virtualization, VMware: full virtualization.

Module 3: Cloud-Enabling Technologies, Private cloud platforms and programming (7Hours)

Broadband networks and internet architecture- Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology. Resource provisioning techniques-static and dynamic provisioning.

Open-source software platforms for private cloud-OpenStack, CloudStack, Basics of Eucalyptus, Open Nebula, Nimbus.

Cloud Programming- Parallel Computing and Programming Paradigms. Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark.

Module 4: Fundamental Cloud Security (7 Hours)

Basic terms and concepts in security- Threat agents, Cloud security threats/risks, Trust. Operating system security-Virtual machine security- Security of virtualization- Security Risks Posed by Shared Images, Security Risks Posed by Management OS. Infrastructure security- Network Level Security, Host Level Security, Application level security, Security of the PhysicalSystems. Identity & Access Management- Access Control.

Module 5: Popular Cloud Platforms (9 Hours)

Amazon Web Services(AWS):- AWS ecosystem- Computing services, Amazon machine images, Elastic Compute Cloud (EC2), Advanced compute services. Storage services-Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS), Database Services, Amazon CDN Services and Communication services.

Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive.

Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Compute services, Storage services.

Text Books:

1. Thomas, E., Zaigham M., Ricardo P "Cloud Computing Concepts, Technology &Architecture.", (2013 Edition). Prentice Hall.
2. Buyya, R., Vecchiola, C., & Selvi, S. T. “Mastering cloud computing: foundations and applications programming”, (2017 Edition), Morgan Kaufmann.
3. Bhowmik, S., “Cloud computing”, (2017 Edition). Cambridge University Press.

References

1. Marinescu, D. C., “Cloud computing: theory and practice.”, (2017 Edition), Morgan Kaufmann
2. Buyya, R., Broberg, J., & Goscinski, A. M., “Cloud computing: Principles and paradigms” (2011 Edition). John Wiley & Sons.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. “*A hybrid cloud is a combination of two or more other cloud deployment models*”. Justify the statement with an example.
2. What are the main characteristics of a Platform-as-a-Service solution?
3. How does cloud computing help to reduce the time to market for applications and to cut down capital expenses?
4. Differentiate public and private clouds in terms of flexibility.

Course Outcome 2 (CO2):

5. Define virtualization. What is the role of VMM in virtualization?
6. Explain various implementation levels of Virtualization.
7. State the differences between a traditional computer and a virtual machine.

Course Outcome 3 (CO3):

8. Differentiate between on-premise and cloud-based inter-networking.
9. What are the benefits of Data Center Technologies?
10. What are the characteristics of Multi-tenant technology?
11. How can virtualization be implemented at the hardware level?

Course Outcome 4 (CO4):

12. Write a Hadoop MapReduce program that counts the number of occurrences of each character in a file.
13. Write a Hadoop MapReduce program to find the maximum temperature in the weather dataset.

Course Outcome 5 (CO5):

14. Why is it harder to establish security in the cloud?
15. Explain in detail about the security issues one should discuss with a cloud-computing vendor.
16. List and Explain major cloud security challenges.

Course Outcome 6 (CO6):

17. Explain the cloud based databases.
18. With a neat diagram, write about Google App Engine for PaaS applications.
19. Differentiate between amazon SimpleDB and Amazon RDS.
2. *"Storage services in the cloud are offered in two different forms as IaaS and as SaaS"*. Explain.

Model Question Paper

QP Code: **Total Pages : 3**

Reg No:________________ **Name :**____________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT352
Course Name: Cloud Computing

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

PART A

Answer all Questions. Each question carries 3 Marks (10 x 3 = 30 Marks)

1. Is the IT outsourcing model of traditional computing similar to cloud computing? Justify.
2. Why is grid computing considered as the predecessor of cloud computing? Explain.
3. What is virtualization and what are its benefits?
4. Explain why a hypervisor is also called a virtual machine monitor?
5. Differentiate between multi-tenancy and virtualization.
6. "*The field of service technology is a keystone foundation of cloud computing*". Explain.
7. Discuss any two identity management techniques used in cloud computing.
8. Differentiate between mandatory access control (MAC) and discretionary Access Control (DAC).
9. Differentiate between Amazon S3 and Amazon EBS.
10. Explain the database service offered by google cloud.

(10 x3 =30)

PART B

Answer any one Question from each Module. Each question carries 14 Marks

11.	**(a)**	Discuss the cloud computing reference model.	**(8)**
	(b)	Which are the basic components of an IaaS-based solution for cloud computing? Also provide some examples of IaaS implementations.	**(6)**
		OR	
12.	**(a)**	List down the characteristics and challenges of cloud computing.	**(6)**
	(b)	Classify the various types of clouds.	**(8)**
13.	**(a)**	List anddiscuss various types of virtualization.	**(8)**
	(b)	Differentiate between full virtualization and paravirtualization.	**(6)**
		OR	
14.	**(a)**	What is Xen? Discuss its elements for virtualization.	**(8)**
	(b)	Explain the design requirements for Virtual Machine Monitor (VMM).	**(6)**
15.	**(a)**	Explain the broadband networks and internet architecture.	**(8)**
	(b)	List and explain the technologies and components of data centers.	**(6)**
		OR	
16.	**(a)**	What are the major functions of the MapReduce framework? Explain the logical data flow of MapReduce function using a suitable example .	**(8)**
	(b)	Write a Hadoop MapReduce program that counts the number of occurrences of each word in a file.	**(6)**
17.	**(a)**	Explain common threats and vulnerabilities in cloud-based environments with suitable examples.	**(8)**
	(b)	Discuss the security risks posed by shared images with suitable examples.	**(6)**

OR

18. **(a)** Explain the operating system security in cloud computing. **(8)**

(b) What do you mean by threat agents?. Explain different types of threat agents. **(6)**

19. **(a)** DescribeAmazon EC2 and its basic features. **(8)**

(b) Illustrate the architecture of Amazon S3. **(6)**

OR

20. **(a)** Describethe core components of Google AppEngine. **(8)**

(b) Explain the architecture of Windows Azure. **(6)**

Teaching Plan

No	**Contents**	**No. of Lecture Hours (37 hrs)**
	Module 1 (Fundamental Cloud Computing) (6 hours)	
1.1	Traditional computing: Limitations.	1
1.2	Overview of Computing Paradigms: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.	1
1.3	NIST reference Model, Basic terminology and concepts.	1
1.4	Cloud characteristics and benefits, challenges. Roles and Boundaries.	1
1.5	Cloud delivery (service) models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), XaaS (Anything-as-a-service).	1
1.6	Cloud deployment models: Public cloud, Community cloud, Private cloud, Hybrid cloud.	1

Module 2(Virtualization) (7 Hours)		
2.1	Introduction to virtualization, Virtualizing physical computing resources Virtual Machines (Machine virtualization):- non-virtualized v/s virtualized machine environments.	1
2.2	Types of VMs: process VM v/s system VM, Emulation, interpretation and binary translation.	1
2.3	Hardware-level virtualization: Hypervisors/VMM, Types of Hypervisors.	1
2.4	Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OS level virtualization.	1
2.5	Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization.	1
2.6	Case Study: Xen: Para-virtualization.	1
2.7	Case Study: VMware: full virtualization.	1
Module 3 (Cloud-Enabling Technologies, Private cloud platforms and programming) (9 Hours)		
3.1	Broadband networks and internet architecture: Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology.	1
3.2	Resource provisioning techniques: static and dynamic provisioning.	1
3.3	Open-source software platforms for private cloud: OpenStack, CloudStack.	1
3.4	Basics of Eucalyptus, Open-Nebula, Nimbus.	1
3.5	Cloud Programming: Parallel Computing and Programming Paradigms.	1
3.6	Map Reduce.	1
3.7	Hadoop Library from Apache, HDFS.	1
3.8	Pig Latin High Level Languages	1
3.9	Apache Spark.	1

Module 4 (Fundamental Cloud Security) (7 Hours)		
4.1	Basic terms and concepts in security, Threat agents.	1
4.2	Cloud security threats/risks, Trust.	1
4.3	Operating system security, Virtual machine security.	1
4.4	Security of virtualization.	1
4.5	Security Risks posed by Shared Images, Security Risks posed by Management OS.	1
4.6	Infrastructure security: - Network Level Security, Host Level Security, Application level security, Security of the Physical Systems.	1
4.7	Identity & Access Management, Access Control.	1
Module 5 (Popular Cloud Platforms) (8 Hours)		
5.1	Amazon Web Services(AWS):- AWS ecosystem, Computing services: Amazon machine images, Elastic Compute Cloud (EC2).	1
5.2	Advanced computing services, Storage services: Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS).	1
5.3	Database Services, Amazon CDN Services and Communication services.	1
5.4	Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage.	1
5.5	PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services.	1
5.6	Database Services, SaaS Offerings: Gmail, Docs, Google Drive.	1
5.7	Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine.	1
5.8	Azure Compute services, Storage services.	1

CST 312	FOUNDATIONS OF MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2019

Preamble:

This course enables the learners to understand the mathematical foundations of Machine Learning concepts. This course covers Linear Algebra, Probability and Distributions. Concepts in this course help the learners to identify the inherent assumptions & limitations of the current methodologies and develop new Machine Learning solutions.

Prerequisite: A sound background in higher secondary school Mathematics.

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

CO 1	Illustrate operations and applications of linear equations, matrix algebra, vector spaces, eigen values & eigenvectors **(Cognitive Knowledge Level: Apply)**
CO 2	Illustrate the concepts of orthogonality & diagonalization. **(Cognitive Knowledge Level: Apply)**
CO 3	Solve computational problems using probability and random variables. **(Cognitive Knowledge Level: Apply)**
CO 4	Identify an appropriate probability distribution for a given discrete or continuous random variable and use its properties. (**Cognitive Knowledge Level: Apply)**
CO 5	Illustrate moment generating function, law of large numbers and central limit theorems (**Cognitive Knowledge Level: 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	✓	✓	✓	✓								✓
CO 2	✓	✓	✓	✓								✓
CO 3	✓	✓	✓	✓								✓
CO 4	✓	✓	✓	✓								✓

CO 5	✓	✓	✓	✓								✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	**30%**	**30%**	**30%**
Understand	**30%**	**30%**	**30%**
Apply	**40%**	**40%**	**40%**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module 1 (LINEAR ALGEBRA)

Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings.

Module 2 (LINEAR ALGEBRA)

Norms - Inner Products, Lengths and Distances, Angles and Orthogonality. Orthonormal Basis, Orthogonal Complement, Orthogonal Projections. Matrix Decompositions - Eigenvalues and Eigenvectors, Eigen decomposition and Diagonalization.

Module 3 (PROBABILITY AND DISTRIBUTIONS)

Probability Space - Sample Spaces, Probability Measures, Computing Probabilities, Conditional Probability, Baye's Rule, Independence. Random Variables - Discrete Random Variables (Bernoulli Random Variables, Binomial Distribution, Geometric and Poisson Distribution, Continuous Random Variables (Exponential Density, Gamma Density, Normal Distribution, Beta Density)

Module 4 (RANDOM VARIABLES)

Functions of a Random Variable. Joint Distributions - Independent Random Variables, Conditional Distributions, Functions of Jointly Distributed Random Variables.

Expected Values - Expected Value of a Random Variable, Expectations of Functions of Random Variables, Expectations of Linear Combinations of Random Variables, Variance and Standard Deviation, Covariance and Correlation, Conditional Expectation

Module 5 (LIMIT THEOREMS)

Moment-Generating Function. Limit Theorems(Proof not expected) - Law of Large Numbers, Convergence in Distribution and the Central Limit Theorem. Distributions derived from the Normal Distribution - Chi-square, t, and F Distributions, Sample Mean and the Sample Variance.

Text book:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (freely available at https://mml – book.github.io)
2. John A. Rice, Mathematical Statistics and Data Analysis, University of California, Berkeley, Third edition, published by Cengage.

Reference books:

1. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition,
2. Axler, Sheldon, Linear Algebra Done Right, 2015 Springer
3. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra, 2018 published by Cambridge University Press

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Find the set S of all solutions in x of the following inhomogeneous linear systems $Ax = b$, where A and b are defined as follows:

$$A = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad b = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix if possible

$$A = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

3. Are the following sets of vectors linearl independent?

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

4. A set of n linearly independent vectors in R^n forms a basis. Does the set of vectors **(2, 4,−3) (0, 1, 1)** , **(0, 1,−1**) form a basis for R^3? Explain your reasons.

Course Outcome 2 (CO2):

1. Determine which of the following sets are orthogonal sets.

$$\left\{\begin{bmatrix}3\\1\\1\end{bmatrix}, \begin{bmatrix}-1\\2\\1\end{bmatrix}, \begin{bmatrix}-1/2\\-2\\7/2\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}1\\-1\\1\end{bmatrix}, \begin{bmatrix}2\\1\\-1\end{bmatrix}, \begin{bmatrix}3\\0\\-3\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}3\\-2\\1\\3\end{bmatrix}, \begin{bmatrix}-1\\3\\-3\\4\end{bmatrix}, \begin{bmatrix}3\\8\\7\\0\end{bmatrix}\right\}$$

2. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue of the following matrix.

$$\begin{bmatrix}2 & 0 & 4\\0 & 3 & 0\\0 & 1 & 2\end{bmatrix}$$

3. Diagonalize the following matrix, if possible

$$\begin{bmatrix}3 & 0 & 0 & 0\\0 & 2 & 0 & 0\\0 & 0 & 2 & 0\\1 & 0 & 0 & 3\end{bmatrix}$$

Course Outcome 2 (CO3):

1. Let ***J*** and ***T*** be independent events, where ***P(J)=0.4*** and ***P(T)=0.7***.
   - ***i.*** Find $P(J \cap T)$
   - ***ii.*** Find $P(J \cup T)$
   - ***iii.*** Find $P(J \cap T')$

2. Let ***A*** and ***B*** be events such that ***P(A)=0.45*** , ***P(B)=0.35*** and $P(A \cup B)=0.5$. Find $P(A|B)$.

3. A random variable **R** has the probability distribution as shown in the following table:

r	1	2	3	4	5
P(R=r)	0.2	a	b	0.25	0.15

i. Given that $E(R)=2.85$, find a and b.
ii. Find $P(R>2)$.

4. A biased coin (with probability of obtaining a head equal to $p > 0$) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.

5. Two players A and B are competing at a quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are p and q respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A wins if
   i. A answers the first question,
   ii. B answers the first question.

6. A coin for which $P(heads) = p$ is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the n^{th} toss.

Course Outcome- 3 (CO4):

1. An urn contains **p** black balls, **q** white balls, and **r** red balls; and **n** balls are chosen without replacement.
   a. Find the joint distribution of the numbers of black, white, and red balls in the sample.
   b. Find the joint distribution of the numbers of black and white balls in the sample.
   c. Find the marginal distribution of the number of white balls in the sample.

2. Suppose that two components have independent exponentially distributed lifetimes, T_1 and T_2, with parameters α and β, respectively. Find (a) $P(T_1 > T_2)$ and (b) $P(T_1 > 2\, T_2)$.

3. Let Z_1 and Z_2 be independent random variables each having the standard normal distribution. Define the random variables X and Y by $X = Z_1 + 3Z_2$ and $Y = Z_1 + Z_2$. Argue that the joint distribution of (X, Y) is a bivariate normal distribution. What are the parameters of this distribution?

4. Given a continuous random variable ***x***, with cumulative distribution function $F_x(x)$, show that the random variable $y = F_x(x)$ is uniformly distributed.
5. You roll a fair dice twice. Let the random variable ***X*** be the product of the outcomes of the two rolls. What is the probability mass function of ***X***? What are the expected values and the standard deviation of ***X***?
6. Let ***X*** be a continuous random variable with the density function $f(x) = 2x,\ 0 \le x \le 1$
   a. Find $E(X)$.
   b. Find $E(X^2)$ and $Var(X)$.

Course Outcome 5 (CO5):

1. Find the moment-generating function of a Bernoulli random variable, and use it to find the mean, variance, and third moment.
2. Use moment-generating functions to show that if **X** and **Y** are independent, then $Var(aX + bY) = a^2Var(X) + b^2Var(Y)$.
3. Suppose that you bet Rs 5 on each of a sequence of 50 independent fair games. Use the central limit theorem to approximate the probability that you will lose more than Rs 75.
4. Suppose that the number of insurance claims, ***N***, filed in a year is Poisson distributed with $E(N) = 10{,}000$. Use the normal approximation to the Poisson to approximate $P(N > 10{,}200)$.

Model Question paper

QP Code : **Total Pages: 4**

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (ELECTIVE), MONTH and YEAR

Course Code: CST 312

Course Name: FOUNDATIONS OF MACHINE LEARNING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1 Show that with the usual operation of scalar multiplication but with addition on reals given by ***x # y = 2(x + y)*** is not a vector space.

2 Are the following vectors linearly independent? Justify your answer.

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

3 Find the eigenvalues of the following matrix in terms of k. Can you find an eigenvector corresponding to each of the eigenvalues?

$$\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$$

4 Find a unit vector in $\mathbf{R}^2$ that is orthogonal to **(-1 , 2)**.

5 The first three digits of a telephone number are 452. If all the sequences of the remaining four digits are equally likely, what is the probability that a randomly selected telephone number contains seven distinct digits?

6 Show that if two events ***A*** and ***B*** are independent, then ***A*** and ***B'*** are independent.

7 Prove that ***X*** and ***Y*** are independent if and only if $f_{X|Y}(x|y) = f_X(x)$ for all ***x*** and ***y***.

8 If ***X*** is a discrete uniform random variable, i.e., $P(X = k) = 1/n$ for $k = 1, 2, \ldots, n$, find $E(X)$ and $Var(X)$.

9 Compare the Poisson cdf and the normal approximation for (a) $\lambda = 10$, (b) $\lambda = 20$, and (c) $\lambda = 40$.

10 State law of large numbers. **10 x 3 = 30**

PART B

Answer any one Question from each module. Each question carries 14 Marks

11 a) Find all solutions to the system of linear equations **(8)**

$$\begin{aligned} -4x + 5z &= -2 \\ -3x - 3y + 5z &= 3 \\ -x + 2y + 2z &= -1 \end{aligned}$$

b) Consider the transformation $T(x, y) = (x + y, x + 2y, 2x + 3y)$. Obtain **ker T** and use this to calculate the nullity. Also find the transformation matrix for **T**. **(6)**

OR

12 a) Consider the following linear mapping **(8)**

$$\Phi : \mathbb{R}^3 \to \mathbb{R}^4$$

$$\Phi\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}\right) = \begin{bmatrix} 3x_1 + 2x_2 + x_3 \\ x_1 + x_2 + x_3 \\ x_1 - 3x_2 \\ 2x_1 + 3x_2 + x_3 \end{bmatrix}$$

i. Find the transformation matrix T.

ii. Determine rank(T).

iii. Compute the kernel and image of the mapping and find their dimension

b) Prove that all vectors orthogonal to **[2, −3, 1]^T** forms a subspace ***W*** of ***R^3***. What is ***dim (W)*** and why? **(6)**

13 a) Find an orthonormal basis of ***R^3*** consisting of eigenvectors for the following matrix **(8)**

$$\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$$

b) Find a 3 × 3 orthogonal matrix ***S*** and a 3 × 3 diagonal matrix ***D*** such that ***A = SDS^T*** **(6)**

OR

14 a) Find an orthogonal basis for the subspace of ***R^4*** spanned by ***{ w_1 = (1, 1, 3, 2), w_2 = (1, −2, 0, −1), w_3 = (0, 2, 1, 2) }***. **(8)**

b) Find the characteristic equation, eigenvalues, and eigenspaces corresponding t each eigenvalue of the following matrix **(6)**

$$\begin{bmatrix} 2 & 0 & 4 \\ 0 & 3 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

15 a) Three players play 10 independent rounds of a game, and each player has probability 1/3 of winning each round. Find the joint distribution of the numbers of games won by each of the three players. **(7)**

b) An experiment consists of throwing a fair coin four times. Find the probability mass function and the cumulative distribution function of the following random variables: **(7)**

i. the number of heads before the first tail

ii. the number of heads following the first tail

iii. the number of heads minus the number of tails

iv. the number of tails times the number of heads.

OR

16 a) A factory runs three shifts. On a given day, 1% of the items produced by the first shift are defective, 2% of the second shift's items are defective, and 5% of the third shift's items are defective. If the shifts all have the same productivity, what percentage of the items produced in a day are defective? If an item is defective, what is the probability that it was produced by the third shift? **(8)**

b) Show that if A and B are two independent events, then $P(A \cup B) = P(A) + P(B) - P(A)P(B)$ **(6)**

17 a) Find the joint density of $X + Y$ and X/Y, where X and Y are independent exponential random variables with parameter λ. Show that $X + Y$ and X/Y are independent. **(8)**

b) Let X be a discrete random variable that takes on values 0, 1, 2 with probabilities 1/2 , 3/8 , 1/8 , respectively. **(6)**

i. Find **E(X)** and **Var(X)**.

ii. Let $Y = X^2$. Find the probability mass function of Y and use it to find **E(Y)**.

18 a) A random square has a side length that is a uniform [0, 1] random variable. Find the expected area of the square. **(7)**

b) Let X be a continuous random variable with probability density function on $0 <= x <= 1$ defined by $f(x) = 3x^2$. Find the pdf of $Y = X^2$. **(7)**

19 a) Using the fact that the mean of the chi-squared distribution is $(n-1)$, prove that $E(S^2) = \sigma^2$. **(7)**

b) i. Random samples of size 36 are taken from an infinite population whose mean is 80 and standard deviation is 18. Find the mean and standard error of the **(7)** sampling distribution.

ii. Why is the Central Limit Theorem so important to statistical analysis?

OR

20 a) A six-sided die is rolled 100 times. Using the normal approximation, find the probability that the face showing a six turns up between 15 and 20 times. Find the probability that the sum of the face values of the 100 trials is less than 300. **(8)**

b) Determine an interval **(a, b)** such that $P[a \leq t \leq b] = 0.80$, and that 10% of the area is on each side of a and b, assuming that the sample is of size 21. **(6)**

Teaching Plan		
No	**Topic**	**No. of Lectures (35)**
1	**Module-1 (LINEAR ALGEBRA) TB-1(Ch 2,3,4) (6 hours)**	
1.1	Systems of Linear Equations – Matrices, Solving Systems of Linear Equations.	1 hour
1.2	Vector Spaces, sub space	1 hour
1.3	Linear Independence,	1 hour
1.4	Basis and Rank	1 hour
1.5.	Linear Mappings- Kernel, Range	1 hour
1.6.	Linear Mappings- Rank, Nullity	
2	**Module-2 (LINEAR ALGEBRA) (6 hours)**	
2.1.	Norms, Inner Products, Lengths and Distances, Angles and Orthogonality,	1 hour
2.2	Orthonormal Basis, Orthogonal Complement,	1 hour
2.3	Orthogonal Projections	1 hour
2.4.	Eigenvalues and Eigenvectors	1 hour
2.5.	Eigen decomposition	1 hour
2.6.	Eigen Diagonalization	1 hour
3.	**Module-3 (PROBABILITY AND DISTRIBUTIONS) TB-2(Ch 1,2) (9 hours)**	

3.1	Sample Spaces, Probability Measures, Computing Probabilities	1 hour
3.2	Conditional Probability,	1 hour
3.3	Baye's Rule	1 hour
3.4	Independence of events	1 hour
3.5	Discrete Random Variables -Bernoulli Random Variables, Binomial Distribution	1 hour
3.6	Discrete Random Variables -Geometric Distribution	1 hour
3.7	Discrete Random Variables -Poisson Distribution	1 hour
3.8	Continuous Random Variables - Exponential Density, Gamma Density,	1 hour
3.9	Continuous Random Variables - Normal Distribution, Beta Density	1 hour
4.	**Module-4 (RANDOM VARIABLES) TB-2 (Ch 3, 4, 5, 6) (9 hours)**	
4.1	Functions of a Random Variable	1 hour
4.2	Joint Distributions - Independent Random Variables	1 hour
4.3	Conditional Distributions	1 hour
4.4	Functions of Jointly Distributed Random Variables	1 hour
4.5	Expected Value of a Random Variable,	1 hour
4.6	Expectations of Functions of Random Variables,	1 hour
4.7	Expectations of Linear Combinations of Random Variables	1 hour
4.6	Variance and Standard Deviation	1 hour
4.9	Covariance and Correlation	1 hour

5	**Module-5 (LIMIT THEOREMS) (6 hours)**	
5.1	Conditional Expectation,	1 hour
5.2	Moment-Generating Function	1 hour
5.3	Limit Theorems(Proof not expected) - Law of Large Numbers,	1 hour
5.4	Convergence in Distribution and the Central Limit Theorem.	1 hour
5.5	Distributions derived from the Normal Distribution - Chi-square and, and F Distributions,	1 hour
5.6	Distributions derived from the Normal Distribution - Sample Mean and the Sample Variance.	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT308	**COMPREHENSIVE COURSE WORK**	**PCC**	**1**	**0**	**0**	**1**

Preamble: The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental Program core courses in the curriculum. Five core courses credited from Semesters 3, 4 and 5 are chosen for the detailed study in this course work. This course has an End Semester Objective Test conducted by the University for 50 marks. One hour is assigned per week for this course for conducting mock tests of objective nature in all the listed five courses.

Prerequisite:

1. CST 201 Data Structures
2. ERT 204 Object Oriented Programming Using Java
3. ERT 305 Data Base Management Systems
4. ERT 203 Digital Systems & VLSI Design
5. ERT 206 Integrated Circuits

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

CO 1	Comprehend the concepts of data structures (Cognitive Knowledge Level: Understand)
CO 2	Comprehend the concepts of logic system design (Cognitive Knowledge Level: Understand)
CO 3	Comprehend the concepts of integrated circuits (Cognitive Knowledge Level: Understand)
CO 4	Comprehend the concepts of data base management system (Cognitive Knowledge Level: Understand)
CO 5	Comprehend the concepts of Object Oriented Programming Using Java (Cognitive Knowledge Level: 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
CO1	✓	✓										✓
CO2	✓	✓										✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓				✓	✓	✓			✓	✓
CO5	✓	✓	✓		✓							✓

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 complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	10
Understand	20
Apply	20
Analyze	
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

End Semester Examination Pattern: Objective Questions with multiple choice (Four). Question paper include Fifty Questions of One mark each covering the five identified courses.

Syllabus

Full Syllabus of all Five selected Courses.

Course Contents and LectureSchedule

No	Topic	No. of Lectures
1	**Data Structures**	
1.1	Mock Test on Module 1 and Module 2	1
1.2	Mock Test on Module 3, Module 4 and Module 5	1
1.3	Feedback and Remedial	1
2	**Logic System Design**	
2.1	Mock Test on Module 1, Module 2 and Module 3	1
2.2	Mock Test on Module 4 and Module 5	1
2.3	Feedback and Remedial	1
3	**Integrated Circuits**	
3.1	Mock Test on Module 1 and Module 2	1
3.2	Mock Test on Module 3, Module 4 and Module 5	1
3.3	Feedback and Remedial	1
4	**Data Base Management Systems**	
4.1	Mock Test on Module 1, Module 2 and Module 3	1
4.2	Mock Test on Module 4 and Module 5	1
4.3	Mock Test on Module 1, Module 2 and Module 3	1
5	**Microprocessors and Microcontrollers**	
5.1	Mock Test on Module 1, Module 2 and Module 3	1
5.2	Mock Test on Module 4 and Module 5	1
5.3	Feedback and Remedial	1

ERL 332	SIGNAL PROCESSING LAB	CATEGORY	L	T	P	CREDIT
		LABORATORY	0	0	3	2

Preamble:
The following experiments are designed to make the students able to perform real time DSP computing.

Dedicated DSP hardware (such as TI or Analog Devices development / Any evaluation boards) may be used for realization.

Simulation experiments may be performed using MATLAB/SCILAB/PYTHON/OCTAVE

Prerequisites:

• ERT 301 Digital Signal Processing

• EST 102 Programming in C

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

CO 1	Simulate digital signals. **(Cognitive Knowledge Level: Understand)**
CO 2	Implement LTI systems with linear convolution. **(Cognitive Knowledge Level: Apply)**
CO 3	Familiarize the DSP hardware and interface with computer. **(Cognitive Knowledge Level: Understand)**
CO 4	Implement FFT and use it on real time signals. **(Cognitive Knowledge Level: Apply)**
CO 5	Implement real time FIR and IIR filter and use it on real time audio signals. **(Cognitive Knowledge Level: 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	✓	✓	✓		✓				✓			✓
CO 2	✓	✓	✓		✓				✓			✓
CO 3	✓	✓	✓		✓				✓			✓
CO 4	✓	✓	✓		✓				✓			✓
CO 5	✓	✓	✓		✓				✓			✓

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:

Each experiment will be evaluated out of 75 marks

Attribute	Marks
Attendance	15 marks
Continuous Assessment	30 marks
Internal Test	30 mark

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

Attribute	Marks
Preliminary work	15 marks
Implementing the work/ Conducting the experiment	10 marks
Performance, result and inference	25 marks
Viva voce	20 marks
Record	5 marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

LIST OF EXPERIMENTS (12 Mandatory)

Part -A

Experiments on Digital Signal Processor/ DSP kits

(4 experiments are mandatory)

1. Generation of sine wave and standard test signals. *
2. Convolution: Linear and Circular. *
3. Real time FFT of the signal using a real-time input signal. *
4. Real Time FIR Filter implementation (Low-pass, High-pass) using a real-time input Signal.*
5. Real Time IIR Filter implementation (Low-pass, High-pass) using a real-time input signal

Part-B

Experiments based on MATLAB/PYTHON/SCILAB/OCTAVE

(8 experiments are mandatory)

1. Generation of Waveforms (Continuous and Discrete).*
2. Time and Frequency Response of LTI systems (First and second order). *
3. Linear Convolution, Circular Convolution and Linear Convolution using Circular Convolution. *
4. To find the DFT and IDFT for the given input sequence. *
5. Linear convolution using DFT. *
6. To find FFT and IFFT for the given input sequence. *

7. FIR and IIR filter design using Filter Design Toolbox. *
8. FIR Filter (Low-pass, High-pass and Band-pass) design (Window method). *
9. IIR Filter (Low-pass, High-pass) design (Butterworth).

*Mandatory experiments

Reference Books

1. Vinay K. Ingle, John G. Proakis,"Digital Signal Processing Using MATLAB",2011
2. Allen B. Downey, "Think DSP: Digital Signal Processing using Python.",2016
3. Rulph Chassaing, "DSP Applications Using C and the TMS320C6x DSK", 2003

ERD334	MINIPROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble:

The course aims

1. To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system or to apply the fundamental concepts of Software Engineering principles for the effective development of an application/research project.
2. Design and development of electronic project based on hardware or a combination of hardware and software for electronics systems which can be developed to a product.
3. This course helps the learners to practice the different steps to be followed in the mini project such as literature review and problem identification, preparation of Software Requirement Specification & Software Design Document (SDD), testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications or develop codes/programs to achieve the objectives, this should be a working model. The basic concept of product design may be taken into consideration. Innovative design concepts, performance, scalability, aesthetics/ergonomic, reliability considerations, user experience and security aspects taken care of in the project shall be given due weight.

Students should identify a topic of interest in consultation with Faculty/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 (hardware/software) has to be demonstrated for its full design specifications.

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

CO1	Apply acquired knowledge within the selected area of technology to develop projects. system (Cognitive Knowledge Level: Apply)
CO2	Apply a systematic approach to analyze, discuss, and justify the technical aspects and design elements of the project. (Cognitive Knowledge Level: Apply)
CO3	Evaluate, reproduce, improve, and refine technical aspects in engineering projects (Cognitive Knowledge Level: Apply)
CO4	Collaborate effectively as a team in the development of technical projects (Cognitive Knowledge Level: Apply)
CO5	Effectively communicate and report project-related activities and findings. (Cognitive Knowledge Level: 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	✓	✓	✓	✓		✓						✓
CO 2	✓	✓	✓	✓		✓					✓	✓
CO 3	✓	✓	✓	✓		✓					✓	✓
CO 4								✓		✓	✓	✓
CO 5								✓	✓	✓		✓

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 complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Evaluation

The internal evaluation will be made 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, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	1 hour

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10

SEMESTER VI

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT382	**INTERNET OF THINGS**	VAC	3	1	0	4

Prerequisite: Nil

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

CO 1	Describe the impact and challenges posed by IoT networks leading to new architectural models. **(Cognitive Knowledge Level: Understand)**
CO 2	Compare and contrast the deployment of smart objects and the technologies to connect them to network. **(Cognitive Knowledge Level: Understand)**
CO 3	Explain the role of IoT protocols for efficient network communication. **(Cognitive Knowledge Level: Understand)**
CO 4	Explain the need for Data Analytics and Security in IoT. **(Cognitive Knowledge Level: Understand)**
CO 5	Illustrate different sensor technologies for sensing real-world entities and develop suitable architectures for applications of IoT in Industry. **(Cognitive Knowledge Level: 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	✓	✓		✓	✓							✓
CO 2	✓	✓										✓
CO 3	✓	✓										✓
CO 4	✓	✓			✓			✓				✓
CO 5	✓	✓	✓	✓	✓	✓	✓					✓

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 complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20	20	30
Understand	30	30	70
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. IoT architecture comparison.

2. Data management and compute stack.

Course Outcome 2 (CO2):

1. IoT access technologies.

2. sensors and actuators.

Course Outcome 3 (CO3):

1. IoT different layers.

2. IoT protocols.

Course Outcome 4 (CO4):

1. Data analytics for IoT

2. IoT security

Course Outcome 5 (CO5):

1. Smart city IoT applications.
2. Fundamentals of Arduino programming.

SYLLABUS

Module 1

What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Module 2:

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

Module 3

IP as the IoT Network Layer, The Business Case for IP, the need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

Module 4

Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment

Module 5

IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. Wireless sensor network, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples, Automation systems with IoT- Home automation- Block diagram of the system, Develop an algorithm, Develop any programming script for implementing the system, and Industrial automation- Block diagram of the system, Develop an algorithm, Develop any programming script for implementing the system.

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Srinivasa K G, "Internet of Things",CENGAGE Leaning India, 2017

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

Model Question Paper

Reg No.:_____ Name:_

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION

MONTH AND YEAR

Course Code: ERT382

Course Name: INTERNET OF THINGS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What is IoT?
2. Write a note on IoT data management
3. Classify actuators based on energy types.
4. Define sensors and actuators.
5. List and explain the advantages of internet protocol.
6. What is the need for optimisation?
7. What do you mean by data and analytics for IoT? Explain.
8. Discuss Bigdata analytics tool and technology.
9. Give a brief note on Arduino UNO.
10. Explain function and variables with respect to Arduino programming.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. A) Explain detail about genesis of IoT. (8 marks)

B) Discuss IoT challenges (6 marks)

12. A) with a neat diagram explain the architecture of IoT (8 marks)

B) Core IoT Functional Stack. (6 marks)

Module 2

13. A) With a neat diagram explain how sensors & actuators interact with physical world. (8 marks)

B) Explain IoT access technologies. (6 marks)

14. A) List and explain different types of sensors (8 marks)

B) Define smart objects. Explain its characteristics? (7 Marks)

Module 3

15. A) Explain the working of IP as the IoT networking layer. (8 Marks)

B) Discuss the various methods used in IoT application transport (6 marks)

16. A) Describe application protocol for IoT. (8 Marks)

B) write a note on IoT application transport methods. (6 Marks)

Module 4

17. A) Explain in detail the core functions of edge analytics with necessary diagrams. (7 Marks)

B) Discuss OCTAVE and FAIR formal risk analysis. (7 marks)

18. A) Explain the formal risk analysis structure. (7 marks)

B) With a case study relate the concept of securing IoT. (7 marks)

Module 5

19. A) Explain the different pins/parts of Arduino Uno board. (7 marks)

B) Explain in detail smart city IoT architecture. (7 marks)

20. A) Explain smart city security architecture. (7 marks)

B) Explain the different layers of IoT with suitable example. (7 marks)

Course Contents and Lecture Schedule

No	Topic	Hours(45)
1	**Module 1**	**10**
1.1	What is IoT, Genesis of IoT.	1
1.2	IoT and Digitization	1
1.3	IoT Impact, Convergence of IT and IoT, IoT Challenges	1
1.4	IoT Network Architecture and Design	1
1.5	Drivers Behind New Network Architectures.	1
1.6	Comparing IoT architectures	1
1.7	A Simplified IoT Architecture – Lecture 1	1
1.8	A Simplified IoT Architecture – Lecture 2	1
1.9	The Core IoT Functional Stack	1
1.10	IoT Data Management and Compute Stack.	1

2	**Module 2**	**8**
2.1	Smart Objects: The “Things” in IoT	1
2.2	Sensors, Actuators and Smart Objects - Lecture 1	1
2.3	Sensors, Actuators and Smart Objects - Lecture 2	1
2.4	Sensor Networks - Lecture 1	1
2.5	Sensor Networks - Lecture 2	1
2.6	Communications Criteria	1
2.7	IoT Access Technologies - Lecture 1	1
2.8	IoT Access Technologies - Lecture 2	1
3	**Module 3**	**9**
3.1	IP as the IoT Network Layer	1
3.2	The Business Case for IP	1
3.3	The need for Optimization	1
3.4	Optimizing IP for IoT	1
3.5	Profiles and Compliances	1
3.6	The Transport Layer - Lecture 1	1
3.7	The Transport Layer - Lecture 2	1
3.8	IoT Application Transport Methods - Lecture 1	1
3.9	IoT Application Transport Methods - Lecture 2	1
4	**Module 4**	**10**
4.1	Data and Analytics for IoT - Lecture 1	1
4.2	Data and Analytics for IoT - Lecture 2	1
4.3	An Introduction to Data Analytics for IoT	1
4.4	Machine Learning, Big Data Analytics Tools and Technology	1
4.5	Edge Streaming Analytics, Network Analytics	1
4.6	Securing IoT, A Brief History of OT Security	1

4.7	Common Challenges in OT Security	1
4.8	How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures	1
4.9	OCTAVE and FAIR	1
4.10	The Phased Application of Security in an Operational Environment	1
5	**Module 5**	**8**
5.1	IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino	1
5.2	Arduino UNO, Installing the Software	1
5.3	Fundamentals of Arduino Programming.	1
5.4	Smart and Connected Cities	1
5.5	An IoT Strategy for Smarter Cities	1
5.6	Smart City IoT Architecture	1
5.7	Smart City Security Architecture	1
5.8	Smart City Use-Case Examples.	1

CST 384	CONCEPTS IN DEEP LEARNING	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

Prerequisite: Sound knowledge in Basics of linear algebra and probability theory.

CO1	Demonstrate basic concepts in machine learning.**(Cognitive Knowledge Level: Understand)**
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets. **(Cognitive Knowledge Level: Understand)**
CO3	Demonstrate the concept of the feed forward neural network and its training process. **(Cognitive Knowledge Level: Apply)**
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases. **(Cognitive Knowledge Level: Apply)**
CO5	Use different neural network/deep learning models for practical applications. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓	✓	✓						✓

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

INTRODUCTION TO DEEP LEARNING

(General Instructions: Instructors are to introduce students to any one software platform and demonstrate the working of the algorithms in the syllabus using suitable use cases and public datasets to give a better understanding of the concepts discussed. Tutorial hour may be used for this purpose)

Module-1 (Introduction)

Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.

Module- 2 (Optimization and Neural Networks)

Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.

Module -3 (Convolutional Neural Network)

Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.

Module- 4 (Recurrent Neural Network)

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.

Module-5 (Application Areas)

Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.

Text Book

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

Reference Books

1. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J MarksII, A Bradford Book,2014
2. Practical Convolutional Neural Networks by MohitSewak, Md. Rezaul Karim, PradeepPujari,Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

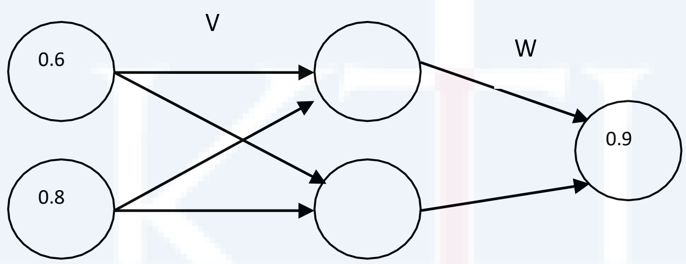
1. Compare regression and classification.
2. Define supervised learning? Distinguish between regression and classification.
3. Discuss the different learning approaches used in machine learning.

Course Outcome 2 (CO2):

1. What are hyperparameters? Why are they needed?
2. What issues are to be considered while selecting a model for applying machine learning in a given problem?

Course Outcome 3 (CO3):

1. Update the parameters V_{11} in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V_{11}= 0.2, V_{12}=0.1, V_{21}=0.1, V_{22}=0.3, V_{11}=0.2, W_{11}=0.5, W_{21}=0.2



2. Draw the architecture of a multi-layer perceptron.
3. Derive update rules for parameters in the multi-layer neural network through the gradient descent.

Course Outcome 4 (CO4):

1. Give two benefits of using convolutional layers instead of fully connected ones for visual tasks.
2. Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?
3. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct
4. Show the steps involved in an LSTM to predict stock prices.

Course Outcome 5 (CO5):

1. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct
2. Show the steps involved in an LSTM to predict stock prices.
3. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Course Outcome 6 (CO6):

1. Development a deep learning solution for problems in the domain i) natural language processing or ii Computer vision (Assignment
2. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Model Question Paper

QP CODE: PAGES:4

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 384

Course Name: CONCEPTS IN DEEP LEARNING

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between supervised learning and Reinforcement learning. Illustrate with an example.

2. Differentiate classification and regression.

3. Compare overfitting and underfitting. How it can affect model generalization.

4. Why does a single perceptron cannot simulate simple XOR function? Explain how this limitation is overcome?

5. Illustrate the strengths and weaknesses of convolutional neural networks.

6. Illustrate convolution and pooling operation with an example

7. How many parameters are there in AlexNet? Why the dataset size (1.2 million) is important for the success of AlexNet?

8. Explain your understanding of unfolding a recursive or recurrent computation into a computational graph.

9. Illustrate the use of deep learning concepts in Speech Recognition.

10. What is an autoencoder? Give one application of an autoencoder

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E." What is your understanding of the terms task, performance and experience. Explain with two example **(10)**

(b) "How does bias and variance trade-off affect machine learning algorithms? **(4)**

OR

12. (a) Illustrate the concepts of Web search, Page Ranking, Recommender systems with suitable examples. **(10)**

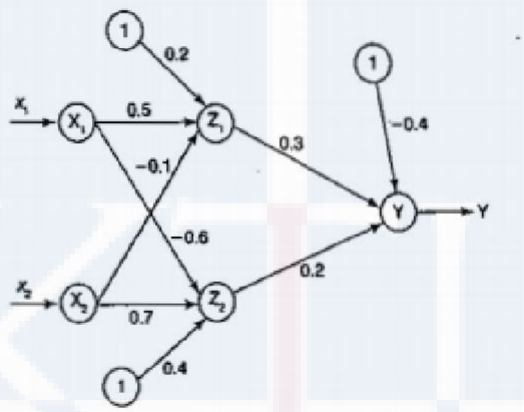
(b) List and discuss the different hyper parameters used in fine tuning the **(4)** traditional machine learning models

13. (a) How multilayer neural networks learn and encode higher level features from input features. **(7)**

(b) Explain gradient decent and delta rule? Why stochastic approximation to gradient descent is needed? **(7)**

OR

14. (a) Find the new weights for the network using backpropogation algorithm, the network is given with a input pattern[-1,1] and target output as +1, Use learning rate of alpha=0.3 and bipolar sigmoid function. **(7)**



(b) Write an algorithm for backpropgation which uses stochastic gradient descent method. Comment on the effect of adding momentum to the network. **(7)**

15. (a) Input to CNN architecture is a color image of size 112x112x3. The first convolution layer comprises of 64 kernels of size 5x5 applied with a stride of 2 and padding 0. What will be the number of parameters? **(5)**

(b) Let X=[-1, 0, 3, 5] W=[.3 ,.5 .2,.1] be the the input of i^{th} layer of a neural network and to apply softmax function. What should be the output of it? **(4)**

(c) Draw and explain the architecture of convolutional network **(5)**

OR

16. (a) Explain the concept behind i) Early stopping ii) dropout iii) weight decay **(9)**

(b) How backpropagation is used to learn higher-order features in a convolutional Network? **(5)**

17. (a) Explain the working of RNN and discuss how backpropagation through time is used in recurrent networks. **(8)**

(b) Describe the working of a long short term memory in RNNs. **(6)**

OR

18. (a) What is the vanishing gradient problem and exploding gradient problem? **(8)**

(b) Why do RNNs have a tendency to suffer from exploding/vanishing gradient? How to overcome this challenge? **(6)**

19. (a) Explain any two word embedding techniques **(8)**

(b) Explain the merits and demerits of using Auto encoders in Computer Vision. **(6)**

OR

20. (a) Illustrate the use of representation learning in object classification. **(7)**

(b) Compare Boltzmann Machine with Deep Belief Network. **(7)**

Teaching Plan

CONCEPTS IN DEEP LEARNING (45 Hours)		
Module 1 : Introduction (9 hours)		
1.1	Key components - Data, models, objective functions, optimization algorithms. (TB2: Section 1.1-1.2)	1 hour

1.2	Learning algorithm (TB1: Section 5.1), Supervised learning- regression, classification (TB2: Section 1.3.1)	1 hour
1.3	tagging, web search, page ranking (TB2: Section 1.3.1)	1 hour
1.4	Recommender systems, Sequence learning, Unsupervised learning, Reinforcement learning(TB2: Section 1.3.2-1.3.4)	1 hour
1.5	Historical Trends in Deep Learning (TB1: Section 1.2).	1 hour
1.6	Concepts: over-fitting, under-fitting, hyperparameters and validation sets. (TB1: Section 5.2-5.3)	1 hour
1.7	Concepts: Estimators, bias and variance. (TB1: Section 5.4)	1 hour
1.8	Demonstrate the concepts of supervised learning algorithms using a suitable platform.	1 hour
1.9	Demonstrate the concepts of unsupervised using a suitable platform.	1 hour
	Module 2 : Optimization and Neural Networks (9 hours)	
2.1	Perceptron, Stochastic Gradient descent, Gradient descent solution for perceptron (TB3: Section 1.1 - 1.2.1)	1 hour
2.2	Multilayer perceptron (TB3: Section 1.2.2), (TB1: Section 6.1,6.3)	1 hour
2.3	Activation functions- Sigmoid, tanh, Softmax, ReLU, leaky ReLU (TB3: Section 1.2.1.3 - 1.2.1.5)	1 hour
2.4	Architecture design (TB1: Section 6.4, TB3: Section 1.6)	1 hour
2.5	Chain rule, back propagation (TB3: Section 1.3)	1 hour

2.6	Gradient based learning (TB1: Section 6.2)	1 hour
2.7	Gradient based optimization (TB1: Section 4.3)	1 hour
2.8	Linear least squares using a suitable platform. (TB1: Section 4.5)	1 hour
2.9	Building ML Algorithms and Challenges (TB3: 1.4, TB1: 5.10-5.11)	1 hour
Module 3 :Convolution Neural Network (10 hours)		
3.1	Convolution operation, Motivation, pooling (TB1:Section 9.1-9.3)	1 hour
3.2	Structure of CNN (TB3: Section 8.2)	1 hour
3.3	Convolution and Pooling as an infinitely strong prior (TB1: Section 9.4)	1 hour
3.4	Variants of convolution functions – multilayer convolutional network, tensors, kernel flipping, downsampling, strides and zero padding. (TB1: Section 9.5)	1 hour
3.5	Variants of convolution functions - unshared convolutions, tiled convolution, training different networks. (TB1: Section 9.5)	1 hour
3.6	Structured outputs, data types (TB1: Section 9.6-9.7)	1 hour
3.7	Efficient convolution algorithms. (TB1: Section 9.8,9.10)	1 hour
3.8	Practical challenges of common deep learning architectures- early Stopping (TB3: 4.6)	1 hour
3.9	Practical challenges of common deep learning architectures- parameter sharing, drop-out (TB3: Section 4.9, 4.5.4)	1 hour
3.10	Case Study: AlexNet,VGG, ResNet. (TB3: Section 8.4.1-8.4.3,8.4.5)	1 hour

Module 4 :Recurrent Neural Network (8 hours)		
4.1	Computational graphs (TB1: Section 10.1)	1 hour
4.2	RNN (TB1: Section 10.2-10.3)	1 hour
4.3	Encoder – decoder sequence to sequence architectures. (TB1: Section 10.4)	1 hour
4.4	Deep recurrent networks (TB1: Section 10.5)	1 hour
4.5	Recursive neural networks , Modern RNNs, (TB1: Section 10.6, 10.10)	1 hour
4.6	LSTM and GRU (TB1: Section 10.10, TB3: Section 7.5-7.6)	1 hour
4.7	Practical use cases for RNNs. (TB1: Section 11.1-11.4)	1 hour
4.8	Demonstrate the concepts of RNN using a suitable platform.	1 hour
Module 5 : Applications and Research (9 hours)		
5.1	Computer vision. (TB1: Section 12.2)	1 hour
5.2	Speech recognition. (TB1: Section 12.3)	1 hour
5.3	Natural language processing. (TB1: Section 12.4)	1 hour
5.4	Common Word Embedding -: Continuous Bag-of-Words, Word2Vec (TB3: Section 2.6)	1 hour
5.5	Common Word Embedding -: Global Vectors for Word Representation(GloVe) (TB3: Section 2.9.1- Pennigton 2014)	1 hour
5.6	Brief introduction on current research areas- Autoencoders, Representation learning. (TB3: Section 4.10)	1 hour

5.7	Brief introduction on current research areas- representation learning. (TB3: Section 9.3)	1 hour
5.8	Brief introduction on current research areas- Boltzmann Machines, Deep belief networks. (TB1: Section 20.1, TB3 Section 6.3)	1 hour
5.9	Brief introduction on current research areas- Deep belief networks. (TB1: Section 20.3)	1 hour

CST 386	WIRELESS NETWORKS AND IoT APPLICATIONS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course equips the learners with fundamental wireless technologies for the Internet of Things(IoT) and the IoT ecosystem. It covers the underlying concepts in wireless networks, communication mechanisms, protocols, hardware, software, and the cloud platforms for IoT. The students will be able to design smart IoT applications for real world problems..

Prerequisite: Sound knowledge in Data Communication, Computer Networks and Programming in C

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

CO1	Recognize wireless technologies required for IoT ecosystem **(Cognitive Knowledge Level : Understand)**
CO2	Perceive the concept of IoT and M2M architecture, IoT examples, and Data Management in IoT **(Cognitive Knowledge Level :Apply)**
CO3	Outline the hardware components used in IoT including Sensors, Actuators and development boards **(Cognitive Knowledge Level : understand)**
CO4	Explain the software components of IoT **(Cognitive Knowledge Level :Understand)**
CO5	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**
CO6	Build IoT-based smart real-time applications such as Smart Healthcare, Smart Agriculture, Smart Environment and Smart Home **(Cognitive Knowledge Level : Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓

CO3	✔	✔	✔	✔	✔							✔
CO4	✔	✔	✔	✔	✔							✔
CO5	✔	✔	✔	✔	✔							✔
CO6	✔	✔	✔	✔	✔	✔						

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 teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Blooms Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Percentage)	**Test 2 (Percentage)**	
Remember	**30**	**30**	**30**
Understand	**50**	**40**	**40**
Apply	**20**	**30**	**30**

Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus, and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module- 1 (Introduction to IoT and wireless technologies required for IoT)

Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT. Protocol Stack - OSI Model, TCP/IP Model, IEEE 802 Reference Model, Protocols for Wireless IoT. Bluetooth - Transceiver, Frequency Channels, Typical Range, Access and Spread Spectrum, Modulation and Data Rate, Error Correction and Detection, Network Topology. ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification, Thread, WiFi, 6LowPAN, IPv6, LoRaWAN.

Module- 2 (IoT architecture, Data and Device management)

Internet of Things - IoT Architectural View, Technology Behind IoT - Server End Technology, Sources of Internet of Things, M2M Communication. IoT Application Areas. IoT Examples. IoT Data Management - Device Management Gateways. Design Principles for Web Connectivity - Web Communication Protocols for Connected Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.

Module- 3 (Data Acquiring and Enabling Technologies)

Data Acquiring and Storage for IoT Sevices- Organization of Data, Big data, Acquiring Methods, Management Techniques, Analytics, Storage Technologies. Cloud Computing for Data storage - IoT Cloud based Services using Xively, Nimbits, and Other Platforms. Sensor Technologies for IoT Devices - Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuators for Various Devices, Sensor Data Communication Protocols, Wireless Sensor network Technology

Module-4 (Prototyping the Embedded Devices for IoT)

Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Intel Galileo, Intel Edison, Raspberry Pi, BeagleBone, mBed. Prototyping and Designing the Software for IoT Applications- Introduction, Prototyping Embedded DeviceSoftware- Programming using Arduino, Programming for an Arduino Controlled Traffic Control Lights at a Road Junction, Basic Arduino Programs to Blink LED, Find the Distance using Ultrasonic Sensor, Estimate Room Temperature, Measuring Soil Moisture Level

Module 5 (Business Models and Case Studies)

Business Models and Processes using IoT. Value Creation in the Internet of Things. Cloud PaaS- Xively, Nimbits, IBM Bluemix, CISCO IoT, AWS IoT, TCS Connected AWS Platform, Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture

Text Books

1. Daniel Chew, “Wireless Internet of Things -A Guide to the lower layers”, IEEE Standards and Association, IEEE Press, Wiley
2. Rajkamal, “Internet of Things : Architecture and Design Principles”, McGraw Hill (India) Private Limited.

References

1. ArshadeepBahga, Vijay Madisetti, “Internet of Things: A hands-on approach”, University Press, 2015 (First edition)
2. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011
3. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013
4. Simon Monk, “Programming Arduino: Getting Started with Sketches”, McGraw Hill Publications

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare Bluetooth and Bluetooth LE power classes
2. Demonstrate Zigbee Specification Protocol Stack

Course Outcome 2 (CO2):

1. What are the major components of IOT system? Briefly explain each
2. Correlate M2M architectural Levels with IOT architectural Levels

Course Outcome 3 (CO3):

1. Describe the use of GPIO pins ?
2. What are actuators ? Mention the roles of actuators in IoT systems

Course Outcome 4(CO4):

1. Identify the role of HBase in Hadoop File System
2. Differentiate Edge computing and Distributed computing
3. Illustrate open protocols, tools and frameworks generally used in M2M

Course Outcome 5(CO5):

1. What do you mean by Arduino sketches?
2. Write an Arduino program to blink LED

Course Outcome 6(CO6):

1. How IoT technology helps TELEMEDICINE in India?
2. How soil moisture can be detected in Smart Agriculture?

Model Question Paper

QP CODE: PAGES :2

Reg No: _______________

Name: _________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 386

Course Name: WIRELESS NETWORKS AND IoT APPLICATIONS

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Illustrate Role of *things* and *internet* in IoT
2. What is Bluetooth? Explain the range and frequency channels of Bluetooth?
3. List any three the features of Constrained Application Protocol (COAP).
4. Compare Raspberry Pi and BeagleBoard boards.
5. Identify the role of HBase in Hadoop File System.
6. Differentiate Edge computing and Distributed computing.
7. Give an example of Raspberry Pi applications for Industrial IoT.
8. What are the on-board functional units in Intel Galileo?
9. Interpret the concept of value creation in IoT.

10. Explain the use of PaaS in IoT Smart applications with any three examples.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Compare various Network topologies used in Wireless Networks. **(8)**

(b) Describe the following wireless technologies on i) *Zigbee* ii) *WiFi* iii) *Thread.* **(6)**

OR

12. (a) Explain protocol stacks used in wireless networks for IoT applications. **(8)**

(b) Illustrate the Architectural design of LoRaWAN. **(6)**

13. (a) Define M2M. Explain M2M architecture. Correlate M2M architectural levels with IoT architectural levels. **(8)**

(b) Compare SOAP and REST protocols. **(6)**

OR

14. (a) Summarize different Online Transactions and Processing techniques. **(8)**

(b) Identify the functions of Device-Management Gateway . **(6)**

15. (a) Define actuators ? Describe the roles of actuators in IoT systems. **(8)**

(b) Explain the usage contexts of analog sensors and digital sensors. **(6)**

OR

16. (a) How data collection, storage & computing services done using Nimbits? **(10)**

(b) List any four features of Xively. **(4)**

17. (a) What do you mean by Arduino sketches? **(4)**

(b) Write an Arduino program to blink LED **(10)**

OR

18. (a) Demonstrate an example of Raspberry Pi applications for Industrial IoT. **(10)**

(b) Compare the features of Arduino-R3 and Arduino Yun boards. **(4)**

19. (a) Explain various tasks of a smart irrigation monitoring service. **(8)**

(b) Demonstrate the tasks of Soil-Moisture monitoring service. **(6)**

OR

20. (a) a) Mr. Kiran Mathew has been a chronic diabetic patient for the past few years. He was under regular check up at the hospital every two weeks. All of a sudden the pandemic like COVID-19 arises in the country and the government issues a lockdown for a period of two months. Illustrate how Mr. Kiran can be monitored by the health care worker using intelligent healthcare techniques. **(10)**

(b) Mention any four sensors used in smart healthcare **(4)**

TEACHING PLAN

No	Contents	No of Lecture Hrs(45)
Module – 1 (Introduction to IoT and wireless technologies required for IoT) (8 hrs) (TB-1, Chapter 1...)		
1.1	Internet Of Things, Role of things and internet ,Wireless IoT	1
1.2	Wireless Networks- Network Topologies-Types of Networks,Role of	1

	Wireless standards in IoT	
1.3	Protocol Stack-OSI Model- TCP/IP Model-IEEE 802 reference model	1
1.4	Protocols for Wireless IoT-Bluetooth-Transceiver, Frequency Channels-Typical Range, Access and Spread Spectrum, Modulation and Data Rate	1
1.5	Error Correction and Detection-Network Topology.	1
1.6	ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification	1
1.7	Thread, Wifi, 6LowPAN, IPv6	1
1.8	LoRaWAN	1
Module- 2 (IOT architecture, Data and Device management) (9hrs)		
2.1	Internet of Things -IoT Architectural view	1
2.2	Technology Behind IOT-Server End Technology,Sources of Internet of Things	1
2.3	M2M Communication.	1
2.4	IoT Application Areas. IOT Examples.	1
2.5	IoT Data Management, Device Management Gateways.	1
2.6	Design Principles for Web Connectivity	1
2.7	Web communication protocols for connected devices,	1
2.8	Web connectivity for connected devices using Gateways.	1
2.9	Internet connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.	1
Module- 3 (Data Acquiring and Enabling Technologies (8 hrs)		
3.1	Data acquiring and storage for IoT devices- Organization of Data, Big data	1
3.2	Acquiring methods, management techniques, Analytics, Storage technologies.	1
3.3	Cloud computing for Data storage-IoT Cloud based services using Xively,	1

	Nimbits, and other platforms.	
3.4	Cloud computing-Nimbits	1
3.5	Sensor Technologies for IoT Devices-Sensor Technology, Participatory sensing	1
3.6	Industrial IoT and Automotive IoT	1
3.7	Actuators for various devices, Sensor data communication protocols	1
3.8	Wireless Sensor network Technology	1
Module 4(Prototyping the Embedded Devices for IoT)(9hrs)		
4.1	Introduction, Embedded Computing Basics, Embedded Hardware Unit.	1
4.2	Embedded Platforms for Prototyping-Arduino, Intel Galileo	1
4.3	Intel Edison, Raspberry Pi, BeagleBone, mBed	1
4.4	Prototyping and designing the software for IoT applications-Introduction, Prototyping embedded device software	1
4.5	Prototyping and designing the software for IoT applications-Introduction, Prototyping embedded device software	1
4.6	Programming concepts in Arduino	1
4.7	Programming for an arduino controlled traffic control lights at a road junction	1
4.8	Basic Arduino programs to blink LED, Find the distance using ultrasonic sensor	1
4.9	Estimate room temperature, Measuring soil moisture level	1
Module 5 (higher level protocols and case studies)(9 hrs)		
5.1	Business Models and Processes using IOT, Value creation in the Internet of Things.	1

5.2	Xively, Nimbits, IBM Bluemix	1
5.3	CISCO IoT, AWS IoT, TCS Connected AWS Platform	1
5.4	Case Study- Smart Environment	1
5.5	Case Study- Smart Environment	1
5.6	Case study Smart Home	1
5.7	Case study Smart Home	1
5.8	Case study Smart healthcare (Lecture I)	1
5.9	Case study Smart healthcare (Lecture II)	1
5.10	Case study -Smart agriculture (Lecture I)	1
5.11	Case study -Smart agriculture (Lecture II)	1

SEMESTER VI

HONOURS

ERT 394	ELECTRONIC DESIGN AND AUTOMATION TOOLS	Category	L	T	P	Credits
		VAC	3	1	0	4

Preamble: This course helps the learners to understand the basic methodology of Digital and Analog system design and to know the EDA tool concepts used for electronic system design for IC and PCB.

Prerequisite: ERT 203 Digital Systems and VLSI Design

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

CO1	Illustrate the basic concepts of EDA, fault simulation and testability **(Cognitive Knowledge Level: Understand)**
CO2	Understand partitioning and formal verification techniques **(Cognitive Knowledge Level: Understand)**
CO3	Explain the fundamentals of design for Testability **(Cognitive Knowledge Level: Understand)**
CO4	Describe the need for library design, ASICs and geometric verification **(Cognitive Knowledge Level: Understand)**
CO5	Explain various assembly & packaging methods **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔		✔							✔
CO2	✔	✔	✔		✔							✔
CO3	✔	✔	✔		✔							✔
CO4	✔	✔	✔		✔							✔
CO5	✔	✔	✔		✔							✔

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and

1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Concept of EDA

Design Methodology, Development steps, Implementation and Verification, Top Down or Bottom Up, Short history of EDA. Digital Simulation: Why? Simulation Model, SDF, Structure of a Digital Simulator, Fault simulation, Performance & Use of logic simulation, Verification of Testability with Simulation, Limits of Digital Simulation.

Module-2: Synthesis

Introduction, Examples, Partitioning, Modification of Hierarchy, Optimization, Retiming, Technology mapping.
Formal Verification: Model checking, Equivalence checking, Fundamental techniques, Sequential circuits, Correctness of Synthesis steps, Design verification.

Module-3: Design for Testability Fundamentals

Faults in Digital circuits and their modeling, Fault simulation and fault collapsing, Digital test pattern generation–ATPG, ATPG algorithms, ATPG- Vector Formats and Compaction and Compression. Scan Architectures- Testability, Scan Registers, Generic scan-based designs, Boundary Scan-JTAG. Built in Self-Test (BIST) - BIST concepts and test pattern generation

Module-4: Library Design

Digital libraries, Pad cell Libraries, Analogue libraries, Macro Libraries. ASICs: Design goals for ASICs, Design Styles. Geometric layout: Standard cell Layouts, LEF data format, GDSII format. Geometric Verification: Introduction, Layer preprocessing, Design Rule check, Extract, Extraction of parasitic capacitors and resistors, ERC, LVS.

Module-5: Assembly & packaging Methods

Die Assembly, Electrical connections, Packaging Methods. PCB Design: PCB design flow, Schematic entry for PCB design, PCB layout

Text Books

1. Jansen, Dirk, "The Electronic Design Automation Handbook", 2003.
2. Miron Abramovici, Melvin A. Breur, Arthur D. Friedman, "Digital Systems Testing and Testable Design", Jaico Publishing House, 2001.
3. ORCAD: Technical Reference Manual, Orcad, and USA.

References

1. M.J.S.Smith. “Application-Specific Integrated Circuits”, Addison Wesley, 2010.
2. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits- a Design perspective”, Pearson education/ Prentice-Hall India Ltd, 2nd edition, 2003.
3. M.H.Rashid, “SPICE FOR Circuits And Electronics Using PSPICE”, Prentice Hall, 2nd edition, 2011.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is Implementation in ASIC design flow

2. Explain the Setup of a simulation system for digital simulation

3. What are the limits of Digital Simulation

Course Outcome 2 (CO2):

1. Write short notes on Optimization strategies
2. fundamental techniques are presented which are used by verification tools
3. Identify and explain the process used to establish the correctness of first design at a high level of abstraction

Course Outcome 3 (CO3):

1. What is fault collapsing
2. Write short notes on Vector Formats and Compaction
3. What is fault simulation

Course Outcome 4 (CO4):

1. What is LEF data format
2. Explain Design Rule check
3. What are Design Styles in ASICs

Course Outcome 5 (CO5):

1. What are the special advantages of eutectic die bonding
2. What are the several requirements to accomplish Packaging?
3. Explain the significance of PCB Design

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:________________
Name:_________________

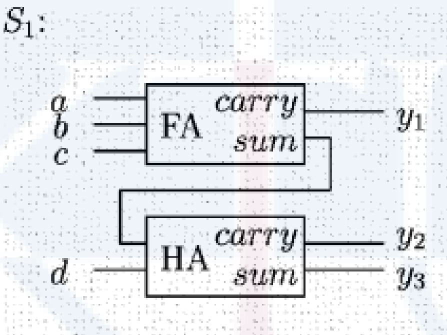
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 394
Course Name: ELECTRONIC DESIGN AND AUTOMATION TOOLS
Max Marks: 100 **Duration: 3 Hours**

PART A
(Answer All Questions. Each question carries 3 marks)

1. What is Verification in ASIC design flow
2. What is the significance of Digital simulation for design verification
3. Differentiate between Ungroup Command and group command
4. Draw S2 , which is a refinement of cell S1 from the 4 to 2 reducer from figure below



5. What are Scan Registers?
6. Briefly explain Fault simulation?
7. List the tasks performed by Pad cells for a chip
8. Illustrate the various design goals for ASICs
9. List the substances that are used as hardeners for adhesives
10. Which are main three kinds of manufacturing processes used? Explain.

Part B
(Answer any one question from each module. Each question carries 14 Marks)

11. Explain the 7 different steps in development

OR

12. Explain the Structure of a Digital Simulator, with diagrams

13. Write short notes on partitioning of the design

OR

14. Identify the method which can be used to prove the correctness of a design by comparing the implemented circuit against another circuit which is known to be correct. Explain the method in Detail
15. What is Built in Self-Test? Explain in detail with diagram.

OR

16. Write short notes on ATPG algorithms
17. Explain the following: (i) Analogue Libraries (ii) macro libraries

OR

18. Briefly explain: (i) ERC (ii) LVS
19. What is Wire Bonding? Name the 2 welding methods used and explain one method in detail with figures.

OR

20. Explain PCB design flow in detail

TEACHING PLAN

No	Contents	No.of Lecture Hrs (42 hrs)
	Module-1: Concept of EDA	**(9 hrs)**
1.1	Design Methodology, Development steps	1
1.2	Implementation and Verification, Top Down or Bottom Up	1
1.4	Short history of EDA	1
1.5	Digital Simulation: Why? Simulation Model	1
1.6	SDF, Structure of a Digital Simulator	1
1.7	Fault simulation, Performance & Use of logic simulation	1
1.8	Verification of Testability with Simulation	1
1.9	Limits of Digital Simulation.	1
	Module-2:Synthesis	**(8 hrs)**
2.1	Introduction, Examples	1
2.2	Partitioning, Modification of Hierarchy	1
2.3	Optimization, Retiming, Technology mapping	1
2.4	Formal Verification: Model checking	1
2.5	Equivalence checking, Fundamental techniques,	1

2.6	Sequential circuits	1
2.7	Correctness of Synthesis steps	1
2.8	Design verification.	1
	Module-3: Design for Testability Fundamentals	**(9 hrs)**
3.1	Faults in Digital circuits and their modeling	1
3.2	Fault simulation and fault collapsing	1
3.3	Digital test pattern generation–ATPG	1
3.4	ATPG algorithms, ATPG- Vector Formats and Compaction and Compression	1
3.5	Scan Architectures- Testability	1
3.6	Scan Registers, Generic scan-based designs	1
3.7	Boundary Scan-JTAG	1
3.8	Built in Self-Test (BIST)	1
3.9	BIST concepts and test pattern generation	1
	Module-4: Library Design	**(9 hrs)**
4.1	Digital libraries, Pad cell Libraries	1
4.2	Analogue libraries, Macro Libraries	1
4.3	ASICs: Design goals for ASICs	1
4.4	Design Styles. Geometric layout: Standard cell Layouts	1
4.5	LEF data format, GDSII format.	1
4.6	Geometric Verification: Introduction	1
4.7	Layer preprocessing, Design Rule check,	1
4.8	Extract, Extraction of parasitic capacitors and resistors	1
4.9	ERC, LVS	1
	Module-5: Assembly & packaging Methods	**(7 hrs)**
5.1	Die Assembly	1
5.2	Electrical connections	1
5.3	Packaging Methods (Lecture 2)	1

5.4	Packaging Methods (Lecture 1)	1
5.5	PCB Design: PCB design flow	1
5.6	Schematic entry for PCB design	1
5.7	PCB layout	1

CST 394	NETWORK SECURITY	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The purpose of this course is to create a better understanding of the network security concepts. This course covers network security standards, email security services, web security mechanisms, firewalls and wireless security mechanisms. This course helps the learner to gain insight into the key aspects of secure network communication and enables to apply in real-life scenarios.

Prerequisite: A sound background in Number Theory and Cryptographic Algorithms.

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

CO#	Course Outcomes
CO1	Identify the key aspects of security, intrusion detection systems and digital signature schemes **(Cognitive Knowledge Level: Apply)**
CO2	Explain the security standards used in network communication **(Cognitive Knowledge Level:Understand)**
CO3	Identify the mechanisms in email security services **(Cognitive Knowledge Level: Apply)**
CO4	Summarize the protocols used to provide web security **(Cognitive Knowledge Level: Understand)**
CO5	Explain the fundamental concepts of wireless network security and firewalls **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
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PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

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 a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1 (Network Security Basics)

Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).

Module – 2 (Network Security Standards)

Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

Module – 3 (Email Security)

Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats. Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.

Module – 4 (Web Security)

Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) – Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.

Module – 5 (Wireless Network Security and Firewalls)

IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.

Text Books

1. C. Kaufman, R. Perlman and M. Speciner, “Network Security: Private Communication in a Public World”, 2/e, PHI.
2. William Stallings, “Cryptography and Network Security Principles and Practice”, 5/e, Pearson

Education Asia.

References

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security”, 3/e, Tata McGraw Hill.
2. Tyler Wrightson, “Wireless Network Security A Beginner’s Guide”, 2012, Tata McGraw Hill.
3. William Stallings, “Network Security Essentials: Applications and Standards”, 4/e, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., “Network Security: The Complete Reference”, Tata McGraw Hill.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Using the Schnorr digital signature scheme, let q = 83, p = 997 and d = 23. Find values for e_1 and e_2.
2. The Digital Signature Algorithm (DSA) specifies that if the signature generation process results in a value of zero, a new value of k should be generated and the signature should be recalculated. Give reason.

Course Outcome 2 (CO2):

1. In Kerberos v4, the authenticator field is not of security benefit when asking the Key Distribution Center (KDC) for a ticket for Bob, but useful when logging in as Bob. Give reasons for your answer.
2. How does the stateless cookie protocol provide clogging protection?

Course Outcome 3 (CO3):

1. If Alice is sending an ENCRYPTED message, she first signs the message digest with her private key and then encrypts the message digest with the pre-message secret key. Why this last encryption was considered necessary for encrypted messages and not for MIC-CLEAR or MIC-ONLY?
2. Which security services are considered desirable in the following cases? (i) Sending a purchase order (ii) Sending a ransom note. (iii) Sending a mission description to security officials.
3. Explain the security mechanism used in Gmail communication.

Course Outcome 4 (CO4):

1. Is it possible in SSL for the receiver to reorder SSL record blocks that arrive out of order? If so, how it can be done? If not, why?
2. Describe any five web security threats, their consequences and countermeasures.

Course Outcome 5 (CO5):

1. Explain the security areas addressed by IEEE 802.11i.
2. Describe the advantages and disadvantages of application layer firewalls.

Model Question Paper

QP CODE:

Reg. No:______________

Name:________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE (HONORS) EXAMINATION, MONTH &YEAR

Course Code: CST 394

Course Name: Network Security

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between signature-based and anomaly-based intrusion detection techniques.

2. A trusted third party is considered as a main component in a network security model. Why?

3. How is endpoint identifier hiding achieved in real-time communication?

4. Show how encryption is used to provide privacy and integrity in Kerberos v5.

5. End-to-end privacy is essential for e-mail security. How is this achieved?

6. List the four steps for preparing an EnvelopedData MIME entity.

7. Show the operation of a Secure Sockets Layer (SSL) Record protocol.

8. For Secure Shell (SSH) packets, what is the advantage of not including the MAC in the scope of packet encryption?

9. List the three security services provided by IEEE 802.11i.

10. Define the terms Access Point, Basic Service Set, Extended Service Set.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Using the ElGamal scheme, let p = 881 and d = 700, find values for e1 and e2. Choose r = 17. Find the value of S1 and S2 if M = 400. **(8)**

(b) Explain the requirements and challenges of network security. **(6)**

OR

12. (a) In ElGamal, Schnorr and DSS, what happens if an attacker can find the value of random secret key used by the signer? Also, what happens if a user uses the same value of random secret key to sign two messages? Explain your answer for each scheme separately. **(8)**

(b) Explain the network security model with the help of a neat diagram. **(6)**

13. (a) Alice wishes to log into Bob's workstation remotely. List the steps involved in this communication if Kerberos v4 is used. **(7)**

(b) How does Diffie-Hellman technique provide perfect forward secrecy using signature keys? **(7)**

OR

14. (a) Explain the algorithm for Message Authentication Code (MAC) calculation and verification in Kerberos v5 rsa-md5-des. **(8)**

(b) Compare the aggressive mode and main mode of Phase 1 Internet Key Exchange (IKE). **(6)**

15. (a) Describe the different methods by which authentication of source is performed in email communication. **(7)**

(b) Explain the Signed data and Clear-signed data functions provided by S/MIME. **(7)**

OR

16. (a) Explain the advantages of Pretty Good Privacy (PGP) over Privacy Enhanced Mail (PEM). **(7)**

(b) Define non-repudiation. Describe the different ways by which it is implemented in email communication. **(7)**

17. (a) Describe the significance of pseudo-random function of Transport Layer Security. **(7)**

(b) Explain the four different phases of Secure Sockets Layer (SSL) HandshakeProtocol. **(7)**

OR

18. (a) Describe how connection initiation and connection closure is done in Hyper Text Transfer Protocol Secure (HTTPS). **(7)**

(b) Illustrate the sequence of events in Secure Shell (SSH) transport layer protocol packet exchanges. **(7)**

19. (a) Explain the Discovery phase and Authentication phase of IEEE 802.11i operation. **(7)**

(b) Why are firewalls needed? Compare the features of packet filters and circuit level firewalls. **(7)**

OR

20. (a) Explain the two authentication methods used in Wired Equivalent Privacy (WEP). **(7)**

(b) Describe the three transaction classes provided by Wireless Transaction Protocol. **(7)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Network Security Basics) (7 hrs)		
1.1	Security requirements, Challenges of security	1
1.2	Network security model	1
1.3	Worms, Viruses, Trojans, Spyware, Adware	1
1.4	Intrusion Detection Systems (IDS) uses, Techniques	1
1.5	ElGamal digital signature	1
1.6	Schnorr digital signature	1
1.7	Digital Signature Standard (DSS)	1
Module - 2 (Network Security Standards) (12 hrs)		
2.1	Kerberos v4 configuration, Authentication	1
2.2	Kerberos v4 encryption	1
2.3	Kerberos v4 message formats	1
2.4	Kerberos v5 cryptographic algorithms – rsa-md5-des, des-mac, des-mac-k	1
2.5	Kerberos v5 cryptographic algorithms - rsa-md4-des, rsa-md4-des-k, Encryption for privacy and integrity	1
2.6	Kerberos v5 message formats	1
2.7	Public Key Infrastructure (PKI) trust models	1
2.8	PKI revocation	1
2.9	Perfect Forward Secrecy (PFS), Denial-of-Service protection	1
2.10	Endpoint identifier hiding, Live partner reassurance	1
2.11	Internet Protocol Security (IPSec) Authentication Header (AH), Encapsulating Security Payload (ESP)	1

2.12	Internet Key Exchange (IKE) phases	1
	Module - 3 (Email Security) (9 hrs)	
3.1	Security services for email, Establishing keys, Privacy	1
3.2	Authentication, Message integrity, Non-repudiation	1
3.3	Privacy Enhanced Mail (PEM) encryption, Source authentication	1
3.4	PEM integrity protection, Message formats (Lecture 1)	1
3.5	PEM message formats (Lecture 2)	1
3.6	Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM	1
3.7	Pretty Good Privacy (PGP) encoding, Certificate and key revocation, Anomalies	1
3.8	PGP Object formats (Lecture 1)	1
3.9	PGP Object formats (Lecture 2)	1
	Module – 4 (Web Security)(9 hrs)	
4.1	Web security considerations, Threats, Secure Sockets Layer (SSL) architecture	1
4.2	SSL protocols (Lecture 1)	1
4.3	SSL protocols (Lecture 2)	1
4.4	Transport Layer Security (TLS) differences from SSL (Lecture 1)	1
4.5	TLS differences from SSL (Lecture 2)	1
4.6	Hypertext Transfer Protocol Secure (HTTPS) connection initiation, Closure	1
4.7	Secure Shell (SSH) transport layer protocol	1
4.8	SSH user authentication protocol	1
4.9	SSH connection protocol	1

Module - 5 (Wireless Security and Firewalls) (8 hrs)		
5.1	IEEE 802.11 Wireless LAN network components, Architectural model, Services	1
5.2	IEEE 802.11i wireless LAN security services, Phases of operation (Lecture 1)	1
5.3	IEEE 802.11i phases of operation (Lecture 2)	1
5.4	Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2	1
5.5	Wireless Application Protocol (WAP) services, Protocol architecture (Lecture 1)	1
5.6	WAP protocol architecture (Lecture 2)	1
5.7	Need for firewalls, Packet filters	1
5.8	Circuit-level firewalls, Application layer firewalls	1

CST 396	ADVANCED TOPICS IN MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course enables the learners to understand the advanced concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning and the naive Bayes algorithm, basic clustering algorithms, auto encoders, sampling methods and PAC learning. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Basic understanding of probability theory, linear algebra, multivariate calculus and multivariate probability theory.

CO1	Illustrate the concepts of regression and classification techniques **(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate various unsupervised learning techniques **(Cognitive Knowledge Level: Apply)**
CO3	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance **(Cognitive Knowledge Level: Apply)**
CO4	Explain the framework of PAC learning, basic concepts of VC dimension and non-uniform learnability **(Cognitive Knowledge Level: Understand)**
CO5	Construct Bayesian models for data and apply computational techniques to draw inferences **(Cognitive Knowledge Level: Apply)**
CO6	Illustrate the concepts of sampling algorithms, auto encoder, generative adversarial networks **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
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Continuous Internal Evaluation Pattern:

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Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

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First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 a student should answer any one. Each question can have a maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module -1 (Supervised Learning)

Overview of machine learning - supervised, semi-supervised, unsupervised learning, reinforcement learning Regression algorithms: least squares linear regression, gradient descent, closed form, normal equations, regularization techniques (LASSO, RIDGE), polynomial regression. Discriminative Methods - Logistic Regression, Decision Tree Learning. Generative Methods - Naive Bayes Classifier, Gaussian Discriminant Analysis (GDA).

Module -2 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, K-medoids clustering, Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model.

Module -3 (Practical aspects in machine learning)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC, generalisation and overfitting, cross-validation, bias-variance tradeoff, error estimation, parameter and model selection. Ensemble Methods - Bagging, Boosting, Adaboost, Random Forests.

Module -4 (Statistical Learning Theory)

Models of learnability- learning in the limit, probably approximately correct (PAC) learning. Sample complexity- quantifying the number of examples needed to PAC learn, Computational complexity of training, Sample complexity for finite hypothesis spaces, PAC results for learning conjunctions, Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis(VC) dimension.

Module -5 (Advanced Machine Learning Topics)

Graphical models - Bayesian belief networks, Markov random fields(MRFs), Inference on chains and factor graphs, inference on clique trees. Monte Carlo methods – Basic sampling algorithms, rejection sampling, importance sampling, Markov chain Monte Carlo(MCMC), Gibbs sampling. Variational methods. Auto Encoder, Variational AutoEncoder, Generative Adversarial Networks

Textbook

1. Christopher M. Bishop. Pattern recognition and machine learning. Springer 2006.
2. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
3. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016.
5. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Learning. Second edition. MIT Press 2018.
6. Tom Mitchell. Machine Learning. McGraw Hill 1997.
7. Richard O. Duda, Peter E . Hart, David G. Stork. Pattern classification, Second Edition. Wiley.
8. Jiawei Han, Micheline Kamber, Jian Pei. Data Mining Concepts and Techniques, Third Edition. Morgan Kaufmann.
9. David Foster. Generative Deep Learning - Teaching Machines to Paint, Write, Compose, and Play. O'Reilly Media, Inc., June 2019.

Reference Books

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012
2. Carl Edward Rasmussen and Christopher K. I. Williams. Gaussian Processes for Machine Learning. MIT Press 2005.

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. Consider a naive Bayes classifier with 3 boolean input variables, $\mathbf{X_1}$, $\mathbf{X_2}$ and $\mathbf{X_3}$, and one boolean output, **Y**. How many parameters must be estimated to train such a naive Bayes classifier? How many parameters would have to be estimated to learn the above classifier if we do not make the naive Bayes conditional independence assumption?
2. Describe the ID3 algorithm. Is the order of attributes identical in all branches of the decision tree?
3. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.
4. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
5. Suppose you have a three class problem where class label $y \in 0, 1, 2$ and each training example $\boldsymbol{X}$ has 3 binary attributes $\boldsymbol{X_1, X_2, X_3} \in \mathbf{0, 1}$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 2(CO2):

1. Which similarity measure could be used to compare feature vectors of two images? Justify your answer.
2. Illustrate the strength and weakness of k-means algorithm.
3. Suppose you want to cluster the eight points shown below using **k**-means

	A_1	A_2
x_1	2	10
x_2	2	5
x_3	8	4
x_4	5	8
x_5	7	5
x_6	6	4
x_7	1	2
x_8	4	9

Assume that **k = 3** and that initially the points are assigned to clusters as follows:

$C_1 = \{x_1, x_2, x_3\}$, $C_2 = \{x_4, x_5, x_6\}$, $C_3 = \{x_7, x_8\}$. Apply the **k**-means algorithm until convergence, using the Manhattan distance.

4. Cluster the following eight points representing locations into three clusters: $A_1(2, 10)$, $A_2(2, 5)$, $A_3(8, 4)$, $A_4(5, 8)$, $A_5(7, 5)$, $A_6(6, 4)$, $A_7(1, 2)$, $A_8(4, 9)$.

   Initial cluster centers are: $A_1(2, 10)$, $A_4(5, 8)$ and $A_7(1, 2)$.

   The distance function between two points $a = (x_1, y_1)$ and $b = (x_2, y_2)$ is defined as $D(a, b) = |x_2 – x_1| + |y_2 – y_1|$

   Use **k**-Means Algorithm to find the three cluster centers after the second iteration.

Course Outcome 3(CO3):

1. What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets?
2. Describe boosting. What is the relation between boosting and ensemble learning?
3. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.
4. What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?
5. Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.

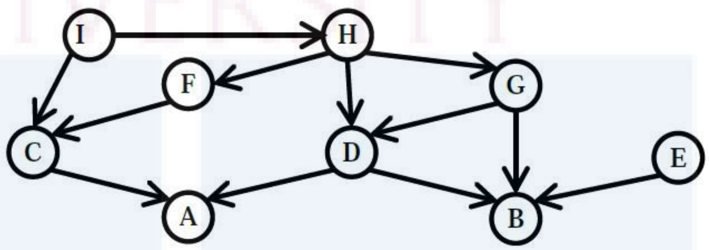
Course Outcome 4(CO4): .

1. A monotone conjunction is a conjunction of the variables such that no variable is negated. Show that the concept class of monotone conjunction is probably approximately correct (PAC)-learnable.
2. Consider a Boolean classification problem with n binary variables and a hypothesis space H, where each hypothesis is a decision tree of depth 2, using only two variables. How many training examples, m suffice to assure that with probability at least 0.99, any consistent learner using H will output a hypothesis with true error at most 0.05
3. Show that the concept class C containing the set of all boolean functions on n variable is not PAC-learnable.

4. What is the Vapnik-Chervonenkis(VC)-dimension of a circle centered at the origin.
5. A hypothesis space that has a high VC dimension is good, bad, or neither? Explain in terms of both (a) richness or expressive power of the hypotheses, and (b) sample complexity.

Course Outcome 5(CO5):

1. Write down the factored conditional probability expression that corresponds to the graphical Bayesian Network shown below.



2. How do we learn the conditional probability tables(CPT) in Bayesian networks if information about some variables is missing? How are these variables called?

Course Outcome 6 (CO6):

1. Derive an algorithm using the inverse transform method to generate a random sample from the exponential distribution.
2. Explain the pros and cons of importance sampling versus rejection sampling.
3. Sketch the core idea of the Monte Carlo method. What is a sample? What is a direct sampling method? Why can't it be used directly to do any inference? What is rejection sampling? What is its major disadvantage?
4. Generative Adversarial Networks(GANs) include a generator and a discriminator. Sketch a basic GAN using those elements, a source of real images, and a source of randomness.
5. The word “adversarial” in the acronym for GANs suggests a two-player game. What are the two players, and what are their respective goals?

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 5**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (HONORS), MONTH & YEAR

Course Code: CST 396

Course Name: Advanced Topics in Machine Learning

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	Suppose you have a dataset with m = 1000000 examples and n = 200000 features for each example. You want to use multivariate linear regression to fit the parameters to our data. Should you prefer gradient descent or the normal equation? Justify your answer.	
2.	Define Information gain? How is that different from Gain ratio? Give the advantage of using Gain ratio measure?	
3.	What is cluster analysis? Identify two applications where cluster analysis can be applied to multimedia data?	
4.	Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8): (i) Compute the Euclidean distance between the two objects. (ii) Compute the Manhattan distance between the two objects.	
5.	Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.	
6.	How Bias-Variance Tradeoff affects machine learning algorithms?	
7.	For a particular learning task, if the requirement of error parameter ε changes from 0.1 to 0.01. How many more samples will be required for probably approximately correct(PAC) learning?	

8.		Suppose we have a hypothesis set that labels all points inside an interval ***[a, b]*** as class 1. Find its Vapnik-Chervonenkis(VC)- dimension?	
9.		Given a density function ***f(x)***, the rejection sampling is a method that can generate data points from the density function ***f***. List the three steps to generate a random sample from f using rejection sampling.	
10.		How does the variational auto-encoder(VAE) architecture allow it to generate new data points, compared to auto-encoder, which cannot generate new data points?	**(10x3=30)**
		Part B **(Answer any one question from each module. Each question carries 14 Marks)**	
11.	(a)	Consider the hypothesis for the linear regression $h_\theta(x) = \theta_0 + \theta_1 x$, and the cost function $J(\theta_0, \theta_1) = 1/2m\ \Sigma_{i=1 \text{ to } m} (h_\theta(x^{(i)}) - y^{(i)})^2$ where m is the number of training examples. Given the following set of training examples. x: 3, 1, 0, 4 y: 2, 2, 1, 3 Answer the following questions : 1) Find the value of $h_\theta(2)$ if $\theta_0 = 0$ and $\theta_1 = 1.5$ 2) Find the value of J(0,1) 3) Suppose the value of $J(\theta_0, \theta_1) = 0$. What can be inferred from this.	**(5)**
	(b)	Write a gradient descent algorithm for multivariate regression? Compare the gradient and analytical solution to the multivariate regression?	**(9)**
		OR	
12.	(a)	Consider the collection of training samples (S) in the Figure given below. Drug is the target attribute which describes the Drug suggested for each patient. Find the value of the following . i) Gain(S, Sex) ii) Gain (S, Cholesterol)	**(9)**

Table for 11(a):

x	y
3	2
1	2
0	1
4	3

Patient ID	Age	Sex	BP	Cholesterol	Drug
p1	Young	F	High	Normal	Drug A
p2	Young	F	High	High	Drug A
p3	Middle-age	F	Hiigh	Normal	Drug B
p4	Senior	F	Normal	Normal	Drug B
p5	Senior	M	Low	Normal	Drug B
p6	Senior	M	Low	High	Drug A
p7	Middle-age	M	Low	High	Drug B
p8	Young	F	Normal	Normal	Drug A
p9	Young	M	Low	Normal	Drug B
p10	Senior	M	Normal	Normal	Drug B
p11	Young	M	Normal	High	Drug B
p12	Middle-age	F	Normal	High	Drug B
p13	Middle-age	M	High	Normal	Drug B
p14	Senior	F	Normal	High	Drug A

(b) Explain how LASSO regression helps to reduce the overfitting problem? **(5)**

13. (a) Suppose that we have the following data: **(9)**

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
(2,0)	(1,2)	(2,2)	(3,2)	(2,3)	(3,3)	(2,4)	(3,4)	(4,4)	(3,5)

Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible.

(b) Describe EM algorithm for Gaussian mixtures. **(5)**

OR

14. (a) Illustrate the strength and weakness of k-means in comparison with the k-medoids algorithm. **(4)**

(b) Suppose that we have the following data . Use single linkage Agglomerative clustering to identify the clusters. Draw the Dendogram. Use Euclidean distance measure **(10)**

	X	Y
P1	0.4	0.53
P2	0.22	0.38
P3	0.35	0.32
P4	0.26	0.19
P5	0.08	0.41
P6	0.45	0.30

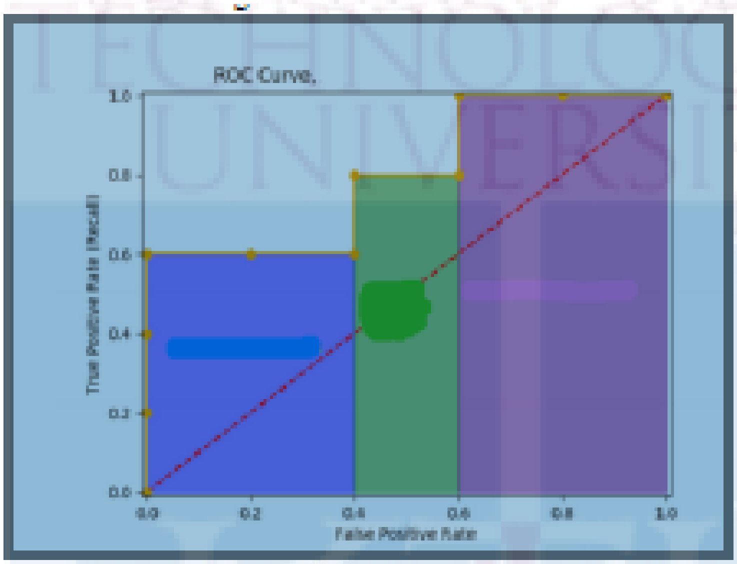
15. (a) Define Precision, Recall, Accuracy and F-measure? **(4)**

(b) What does it mean for a classifier to have a high precision but low recall? **(3)**

(c) Fill in the missing values in the accompanying three class confusion matrix. Given that model accuracy is 72% and classification error for class 2 is 20%. Find also the precision and recall for class1 **(7)**

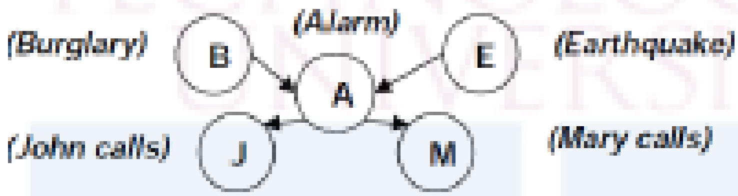
		Predicted		
		Class 1	**Class 2**	**Class 3**
Actual	**Class 1**	14	2	5
	Class 2	?(X)	40	2
	Class 3	1	?(Y)	18

OR

16.	(a)	What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?	**(4)**
	(b)	Given the following ROC Curve? Find the AUC? 	**(3)**
	(c)	How does random forest classifier work? Why is a random forest better than a decision tree?	**(7)**
17.	(a)	Show that the concept class Cn of the conjunction of boolean literals up to n variables is probably approximately correct(PAC)-learnable.	**(8)**
	(b)	Explain the concept of Vapnik-Chervonenkis (VC) dimension using shattering. How the number of training examples required to train the model is related to the VC dimension and what is its relation with training and test errors.	**(6)**
OR			
18.	(a)	Consider a Boolean classification problem with ***n*** binary variables and a hypothesis space ***H***, where each hypothesis is a decision tree of depth 1. How many training examples, ***m*** suffice to assure that with probability at least 0.99, any consistent learner using ***H*** will output a hypothesis with true error at most 0.05?	**(7)**
	(b)	Prove that VC(H) ≤ log2 |H|, where H is a hypothesis space. (|H| denotes the	**(7)**

cardinality of the hypothesis space)

19. (a) Shown below is the Bayesian network corresponding to the Burglar Alarm problem, P(J | A) P(M | A) P(A | B, E) P(B) P(E). The probability tables show the probability that variable is True, e.g., P(M) means P(M = t). Find P(J = t ∧ M = f ∧ A = f ∧ B = f ∧ E = t). **(7)**



P(E)
.002

P(B)
.001

A	P(M)
t	.70
f	.01

A	P(J)
t	.90
f	.05

B	E	P(A)
t	t	.95
t	f	.94
f	t	.29
f	f	.001

(b) Derive an algorithm using the inverse transform method to generate a random sample from the distribution with density $f_X(x) = 3x^2,\ 0 < x < 1$. **(7)**

OR

20. (a) Draw the Bayesian Network that corresponds to this conditional probability: ***P(A | B,C,E) P(B | D,E) P(C | F,H) P(D | G) P(E| G,H) P(F | H) P(G) P(H)*** **(6)**

(b) What is effective sample size (ESS)? Why is a large ESS necessary but not sufficient for good MCMC mixing? **(3)**

(c) Describe the overall Gibbs sampling algorithm briefly **(5)**

Teaching Plan

Module 1 : (Supervised Learning)(10 hours)		
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (TB 2: Ch 1)	1 hour
1.2	Least squares linear regression (TB 2: Section 2.6)	1 hour
1.3	Gradient descent, closed form, normal equations (TB 2: Section 5.8)	1 hour
1.4	Regularization techniques (LASSO, RIDGE) (TB 4: Section 7.1)	1 hour
1.5	Polynomial regression (TB 2: Section 2.6)	1 hour
1.6	Logistic Regression (TB 6: Section 3.3)	1 hour
1.7	Decision Tree Learning (ID3) (TB 8: Section 8.2)	1 hour
1.8	Decision Tree Learning (C4.5) (TB 8: Section 8.2)	1 hour
1.9	Naive Bayes Classifier (TB 8: Section 8.3)	1 hour
1.10	Gaussian Discriminant Analysis (GDA) (TB 7: Section 5.2,5.3)	1 hour
Module 2 : (Unsupervised Learning)(8 hours)		
2.1	Similarity measures (TB 8: Section 2.4)	1 hour
2.2	Hierarchical Agglomerative Clustering (TB 3: Chapter 14)	1 hour
2.3	Hierarchical Agglomerative Clustering (TB 3: Chapter 14)	
2.4	K-means partitional clustering (TB 3: Chapter 13)	1 hour
2.5	K-medoids partitional clustering	
2.6	Gaussian mixture models (TB 3: Chapter 13)	1 hour
2.7	Expectation Maximization (EM) algorithm for Gaussian mixture model Lecture-1 (TB 3: Chapter 13)	1 hour
2.8	Expectation Maximization (EM) algorithm for Gaussian mixture model Lecture-2 (TB 3: Chapter 13)	1 hour
Module 3 : (Practical aspects in machine learning) (6 hours)		

3.1	Precision, Recall, Accuracy, F-Measure, ROC, AUC (TB8.5/TB 3: Chapter 22.1)	1 hour
3.2	Generalisation and overfitting, cross-validation (TB 2: Section 2.7,4.8)	1 hour
3.3	Bias-variance tradeoff (TB 2: Chapter 22.3)	1 hour
3.4	Error estimation, parameter and model selection (TB 3: Chapter 8.5)	1 hour
3.5	Bagging, Boosting (TB 8: Chapter 8.6)	1 hour
3.6	Adaboost, Random Forests (TB 8: Chapter 8.6)	1 hour
Module 4 : (Statistical Learning Theory) (TB 5 – Chapter 2, 3.3)(7 hours)		
4.1	Learning in the limit, probably approximately correct (PAC) learning	1 hour
4.2	Quantifying the number of examples needed to PAC learn	1 hour
4.3	Computational complexity of training	1 hour
4.4	Sample complexity for finite hypothesis spaces	1 hour
4.5	PAC results for learning conjunctions	1 hour
4.6	Sample complexity for infinite hypothesis spaces	1 hour
4.7	Vapnik-Chervonenkis(VC) dimension	1 hour
Module 5 : (Advanced Machine Learning Topics) (13 hours)		
5.1	Bayesian belief networks (TB 1 – Chapter 8)	1 hour
5.2	Markov random fields (TB 1 – Chapter 8)	1 hour
5.3	Inference on chains and factor graphs (TB 1 – Chapter 8)	1 hour
5.4	Inference on clique trees (TB 1 – Chapter 8)	1 hour
5.5	Basic sampling algorithms (TB 1 – Chapter 11)	1 hour
5.6	Rejection sampling (TB 1 – Chapter 11)	1 hour
5.7	Importance sampling (TB 1 – Chapter 11)	1 hour
5.8	Markov chain Monte Carlo(MCMC) (TB 1 – Chapter 11)	1 hour
5.9	Gibbs sampling (TB 1 – Chapter 11)	1 hour

5.10	Variational method (TB 1 – Chapter 10)	1 hour
5.11	Auto Encoder (TB 4 – Chapter 14)	1 hour
5.12	Variational AutoEncoder (TB 9 – Chapter 3)	1 hour
5.13	Generative Adversarial Networks (TB 9 – Chapter 4)	1 hour