ECT281	ELECTRONIC CIRCUITS	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to develop the skill of the design of various analog circuits.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

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

CO 1	Realize simple circuits using diodes, resistors and capacitors
CO 2	Design amplifier and oscillator circuits
CO 3	Design Power supplies, D/A and A/D convertors for various applications
CO4	Design and analyze circuits using operational amplifiers

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse	K4			
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): Realize simple circuits using diodes, resistors and capacitors.

1. For the given specification design a differentiator and integrator circuit.
2. For the given input waveform and circuit, draw the output waveform and transfer characteristics.
3. Explain the working of RC differentiator and integrator circuits and sketch the output waveform for different time periods.

Course Outcome 2 (CO2): Design amplifier and oscillator circuits.

1. For the given transistor biasing circuit, determine the resistor values, biasing currents and voltages.
2. Explain the construction, principle of operation, and characteristics of MOSFETs.
3. Design a RC coupled amplifier for a given gain.
4. Design a Hartley oscillator to generate a given frequency.

Course Outcome 3 (CO3): Design Power supplies, D/A and A/D convertors for various applications.

1. Design a series voltage regulator.
2. For the regulator circuit, find the output voltage and current through the zener diode.
3. In a 10 bit DAC, for a given reference voltage, find the analog output for the given digital input.

Course Outcome 4 (CO4): Design circuits using operational amplifiers for various applications

1. For the given difference amplifier, find the output voltage.
2. Derive the expression for frequency of oscillation of Wien bridge oscillator using op-amp.
3. Realize a summing amplifier to obtain a given output voltage.

SYLLABUS

Module 1:

Wave shaping circuits: Sinusoidal and non-sinusoidal wave shapes, Principle and working of RC differentiating and integrating circuits, Clipping circuits - Positive, negative and biased clipper. Clamping circuits - Positive, negative and biased clamper.

Transistor biasing: Introduction, operating point, concept of load line, thermal stability (derivation not required), fixed bias, self bias, voltage divider bias.

Module 2:

MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics.

Amplifiers: Classification of amplifiers, RC coupled amplifier – design and working, voltage gain and frequency response. Multistage amplifiers - effect of cascading on gain and bandwidth.

Feedback in amplifiers - Effect of negative feedback on amplifiers.

MOSFET Amplifier- Circuit diagram, design and working of common source MOSFET amplifier.

Module 3:

Oscillators: Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (design equations and working of the circuits; analysis not required).

Regulated power supplies: Review of simple zener voltage regulator, series voltage regulator, 3 pin regulators-78XX and 79XX, DC to DC conversion, Circuit/block diagram and working of SMPS.

Module 4 : Operational amplifiers: Characteristics of op-amps(gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp(IC741), applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator, Comparator, Instrumentation amplifier.

Module 5:

Integrated circuits: D/A and A/D convertors – important specifications, Sample and hold circuit, R-2R ladder type D/A convertors.

Flash and sigma-delta type A/D convertors.

Text Books

1. Robert Boylestad and L Nashelsky, Electronic Devices and Circuit Theory, Pearson, 2015.
2. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008.

Reference Books

1. David A Bell, Electronic Devices and Circuits, Oxford University Press, 2008.

2. Neamen D., Electronic Circuits, Analysis and Design, 3/e, TMH, 2007.

3. Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010.

4. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, PHI, 2000.

5. K.Gopakumar, Design and Analysis of Electronic Circuits, Phasor Books, Kollam, 2013

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Wave shaping circuits**	
1.1	Sinusoidal and non-sinusoidal wave shapes	1
1.2	Principle and working of RC differentiating and integrating circuits	2
1.3	Clipping circuits - Positive, negative and biased clipper	1
1.4	Clamping circuits - Positive, negative and biased clamper	1
	Transistor biasing	
1.5	Introduction, operating point, concept of load line	1
	Thermal stability, fixed bias, self bias, voltage divider bias.	3
2	**Field effect transistors**	
2.2	MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics	2
	Amplifiers	
2.3	Classification of amplifiers, RC coupled amplifier - design and working voltage gain and frequency response	3
2.4	Multistage amplifiers - effect of cascading on gain and bandwidth	1
2.5	Feedback in amplifiers - Effect of negative feedback on amplifiers	1
	MOSFET Amplifier- Circuit diagram, design and working of common source MOSFET amplifier	2
3	**Oscillators**	
3.1	Classification, criterion for oscillation	1
3.2	Wien bridge oscillator, Hartley and Crystal oscillator	3
	Regulated power supplies	
3.3	simple zener voltage regulator, series voltage regulator line and load regulation	3
3.4	3 pin regulators-78XX and 79XX	1
3.5	DC to DC conversion, Circuit/block diagram and working of SMPS	1
4	**Operational amplifiers**	
4.1	Differential amplifier	2
4.2	characteristics of op-amps(gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp(IC741)	2
4.3	applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator	3

4.4	Comparator, Schmitt trigger, Linear sweep generator	3
5	**Integrated circuits**	
5.1	D/A and A/D convertors – important specifications, Sample and hold circuit	1
5.2	R-2R ladder type D/A convertors	2
5.3	Flash and successive approximation type A/D convertors	2
5.4	Circuit diagram and working of Timer IC555, astable and monostable multivibrators using 555	3

Assignment:

Atleast one assignment should be simulation of transistor amplifiers and op-amps on any circuit simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT281

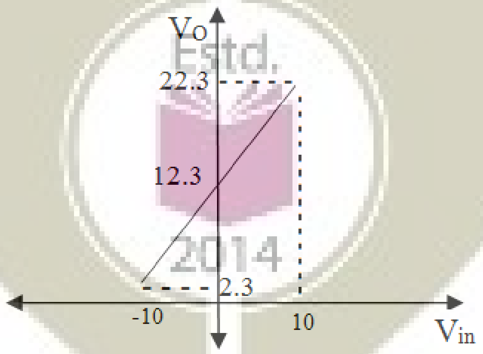
Course Name: ELECTRONIC CIRCUITS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1 Design a clamper circuit to get the following transfer characteristics, assuming voltage drop across the diode s 0.7V. K3



2 Give the importance of biasing in transistors? Mention significance of operating point. K2

3 What is line regulation and load regulation in the context of a voltage regulator? Explain with equation for percentage of regulation:- K2

4 Compare the features of FET with BJT:- K1

5 What is the effect of cascading in gain and bandwidth of amplifier? K1

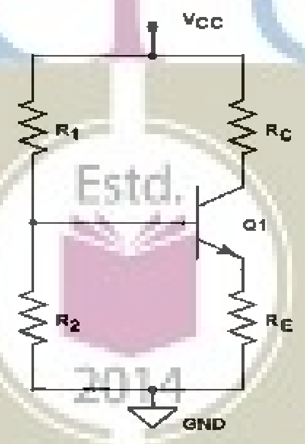
6	Discuss about simple zener shunt voltage regulator:-	K1
7	Realize a circuit to obtain $V_o= -2V_1+3V_2+4V_3$ using operational amplifier. Use minimum value of resistance as 10KΩ.	K3
8	Design a monostable multivibrator using IC 555 timer for a pulse period of 1 ms.	K3
9	Describe the working of a Flash type A/D Converter, with example.	K2
10	Define: (1) Slew rate, (2) CMRR, (3) offset voltage and current:-	K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

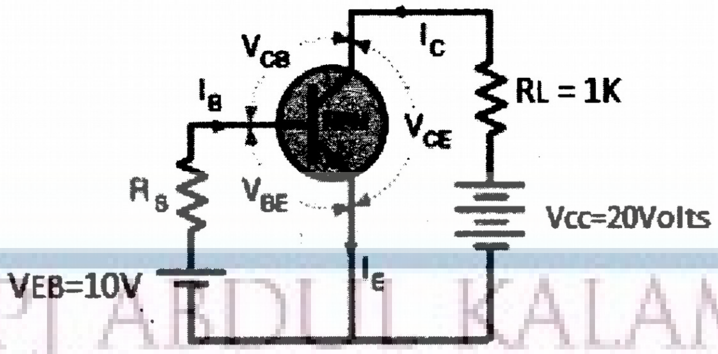
11 a.	Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz:-	5 CO1 K3
b.	Consider a self-biasing circuit shown in figure below with Vcc=20V, R_c=1.5KΩ, which is operated at Q-point (Vce=8V, Ic=4mA), If h_{FE}=100, find R_1, R_2 and R_e. Assume V_{BE}=0.7V.	9 CO2 K3



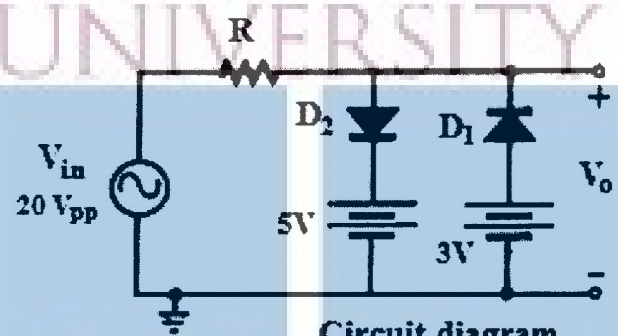
OR

12 a.	Explain the working of an RC differentiator circuit for a square wave input with period T.Sketchits output waveform for RC ≫ T ,RC ≪ T and RC = T.	5 CO1 K3
b.	With reference to the following circuit, draw the load line and mark the Q point of a Silicon transistor operating in CE mode based on the following data (β=80, Rs=47KΩ, R_L=1KΩ, neglect I_{CBO})	5 CO2

K3



c.	Draw the output waveform and transfer characteristics of the given clipper circuit.	4 CO1 K3



Circuit diagram

Module - II

13 a.	With neat sketches, explain the construction, principle of operation and characteristics of an N-channel enhancement MOSFET:-	9 CO2 K2
b.	Draw the circuit of an RC coupled amplifier and explain the function of each element:-	5 CO2 K2

OR

14 a.	Draw the circuit of a common source amplifier using MOSFET. Derive the expressions for voltage gain and input resistance:-	9 CO2 K2
b.	Sketch the frequency response of an RC coupled amplifier and write the reasons for gain reduction in both ends.	5 CO2 K2

Module - III

15 a.	Design a Hartley oscillator to generate a frequency of 150KHz.	5 CO2

K3

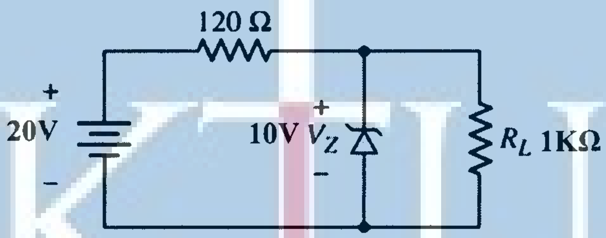
b. Draw the circuit of a series voltage regulator. Explain its working when the input voltage as well as load current varies. Design a circuit to deliver 5V, 100mA maximum load current:- 9 CO3 K3

OR

16 a. With neat diagram and relevant equations explain the working of wein bridge oscillator using BJT:- 7 CO2 K2

b. Derive the expression for the frequency of oscillation of Wien bridge oscillator using BJT 4 CO2 K2

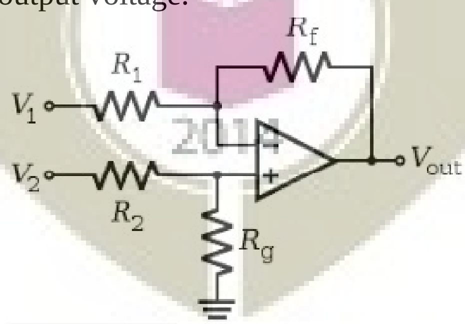
c. For the circuit shown below, find the ouput voltage across RL and current through the zener diode:- 3 CO3 K3



Module - IV

17 a. With circuit, relevant equations and waveforms explain the working of a Schmit trigger using op-amp:- 10 CO4 K2

b. The difference amplifier shown in the figure have R_1=R_2=5KΩ, R_F=10KΩ, R_g=1KΩ. Calculate the output voltage. 5 CO4 K3



OR

18 a. With circuits and equations show that an op-amp can act as integrator, differentiator, adder and subtractor. 9 CO4 K2

b.	What do you mean by differential amplifier? With neat sketches, explain the working of an open loop OP-AMP differential amplifier.	5 CO4 K2

Module - V

19 a.	Explain the working of R-2R ladder type DAC. In a 10 bit DAC, reference voltage is given as 15V. Find analog output for digital input of 1011011001.	10 CO3 K3
b.	With neat diagram explain the working of IC555 timer.	4 CO4 K3

OR

20 a.	A 4-bit R-2R ladder type DAC having R= 10 kΩ and V_R= 10 V. Find its resolution and output voltage for an input 1101.	4 CO4 K3
b.	Design an astable multivibrator using IC 555 timer for a frequency of 1KHz and a duty cycle of 70%.Assume c=0.1µF.	5 CO4 K3
c.	Draw the circuit diagram of a simple sample and hold circuit and explain the necessity of this circuit in A to D conversion.	5 CO4 K2

Simulation Assignments

The following simulations can be done in QUCS, KiCad or PSPICE.

1. Design and simulate RC coupled amplifer. Observe the input and output signals. Plot the AC frequency response and understand the variation of gain at high frequencies. Observe the effect of negative feedback by changing the capacitor across the emitter resistor.

2. Design and simulate Wien bridge oscillator for a frequency of $10\,kHz$. Run a transient simulation and observe the output waveform.

3. Design and simulate series voltage regulator for output voltage $V_O = 10V$ and output current $I_O = 100mA$ with and without short circuit protection and to test the line and load regulations.

4. Design and implement differential amplifier and measure its CMRR. Plot its transfer characteristics.

5. Design and simulate non-inverting amplifier for gain 5. Observe the input and output signals. Run the ac simulation and observe the frequency response and $3-$ db bandwidth.

6. Design and simulate a 3 bit flash type ADC. Observe the output bit patterns and transfer characteristics

7. Design and simulate $R - 2R$ DAC ciruit.

8. Design and implement Schmitt trigger circuit for upper triggering point of $+8\,V$ and a lower triggering point of $-4\,V$ using op-amps.

ECT282	Microcontrollers	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to impart the overview of a microcontroller-based system design and interfacing techniques.

Prerequisite: Nil

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

CO 1 K2	Explain the building blocks of a typical microcomputer/microcontroller system
CO 2 K2	Familiarize the instruction set of 8051 and perform assembly language programming
CO 3 K3	Interface the various peripheral devices to the microcontroller using assembly/ C programming
CO4 K3	Realize external communication interface to the microcontroller
CO5 K2	Familiarize the building blocks of RISC Processors and ARM microcontrollers

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											2
CO 2	3				3							2
CO 3	3	2	3		3							2
CO 4	3	2	3		3							2
CO5	3											2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
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.

Syllabus

Module 1: Computer Arithmetic and Processor Basics

Functional units of a computer, Von Neumann and Harvard computer architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute.

Module 2: 8051 Architecture

Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Addressing Modes, Instruction set (brief study of 8051 instruction set is sufficient).

Module 3: Programming and Interfacing of 8051

Simple programming examples in assembly language: Addition, Subtraction, Multiplication and Division. Interfacing of LCD display, Keyboard, Stepper Motor, DAC and ADC with 8051.

Module 4: Open Source Embedded Development Boards

Introduction. ATmega2560 microcontroller- Block diagram and pin description. Arduino Mega **256** board – Introduction and pin description. Simple Applications - Solar Tracker, 4-Digit 7-Segment LED Display, Tilt Sensor, Home Security Alarm System, Digital Thermometer, IoT applications.

Module 5: ARM Based System

Introduction - ARM family, ARM 7 register architecture, ARM programmer's model. Raspberry pi 4 board – Introduction and brief description. Applications - Portable Bluetooth speaker, Remote-controlled car, Photo Booth, IoT weather station, Home automation centre, Portable Digital eBook Library.

Text Books

1. Computer Architecture and Organization: From 8085 to Core2Duo and beyond, Subrata Ghoshal, Pearson, 2011.
2. The 8051 microcontroller and Embedded System, Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, Pearson Education, 2nd edition.

Reference Books

1. The 8051 Microcontrollers: Architecture Programming and Applications, K Uma Rao & Andhe Pallavi, Pearson, 2011.
2. ARM System - on-chip Architecture, Steve Furber, Pearson Education

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Computer Arithmetic and Processor Basics**	
1.1	Functional units of a computer, Von Neumann and Harvard computer architectures	2
1.2	Processor Architecture – General internal architecture	1
1.3	Address bus, Data bus, control bus	1
1.4	Register set – status register, accumulator, program counter, stack pointer, general purpose registers.	2
1.5	Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute	3
2	**8051 Architecture**	
2.1	Architecture – Block diagram of 8051	1
2.2	Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts.	3
2.3	Addressing Modes of 8051	1
2.4	Instruction sets (brief study of 8051 instructions)	4
3	**Programming and Interfacing of 8051**	
3.1	Simple programming examples in assembly language	1
3.2	Addition, Subtraction, Multiplication and Division	2
3.3	Interfacing of 7 segment LCD display	1
3.4	Interfacing of Keyboard and stepper motor	2
3.5	Interfacing of DAC and ADC	3
4	**Open Source Embedded Development Boards**	
4.1	Introduction to open source boards	1
4.2	ATmega2560 microcontroller- Block diagram and pin description	3
4.3	Arduino Mega **256** board – Introduction and pin description	2
4.4	Simple Applications - Solar Tracker, 4-Digit 7-Segment LED Display, Tilt Sensor, Home Security Alarm System, Digital Thermometer, IoT applications	3
5	**ARM Based System**	

5.1	Introduction - ARM family, ARM 7 register architecture, ARM programmer's model	3
5.2	Raspberry pi 4 board – Introduction and brief description	2
5.3	Applications - Portable Bluetooth speaker, Remote-controlled car, Photo Booth, IoT weather station, Home automation centre, Portable Digital eBook Library	4

MODEL QUESTION PAPER

			Total Pages: 2
Reg No.:_______________			Name:___________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, ____________ 20__

Course Code: ECT 282

Course Name: MICROCONTROLLERS

Max. Marks: 100 | Duration: 3 Hours

PART A

	Answer all questions; each question carries 3 marks.	Marks
1	Distinguish between Harvard and Von-Neumann architecture.	(3)
2	Write down the control signal for a register transfer.	(3)
3	Explain the concept of memory banks in 8051.	(3)
4	Mention the difference between AJMP, LJMP and SJMP instructions.	(3)
5	Write a program to multiply two 8 bit numbers from external memory in 8051microcontroller	(3)
6	Explain the format of SCON special function register.	(3)
7	Discuss the features of ARM processor.	(3)
8	How do you interface an ADC with 8051?	(3)
9	List 5 main features of Atmega 2560 microcontroller	(3)
10	Give 5 features of ARM processors.	(3)

PART B

Answer one question from each module; each question carries 14 marks.

		Module 1	
1	a)	Explain the different stages of microprocessor operations.	(6)
	b)	Explain the role of different buses in a processor architecture.	(8)
		OR	
2	a)	Explain the data path for branch execution showing all control signals and sequences.	(6)
	b)	Explain the function of following registers: status register, accumulator, program counter, stack pointer, general purpose registers.	(8)
		Module 2	
3	a)	Draw the circuit diagram of port 1 and port 2 and describe their operation briefly.	(8)
	b)	Explain the internal architecture of 8051 microcontroller with a block diagram.	(6)
		OR	
4	a)	Briefly explain the following instructions of 8051: (i) MOV A, @Ri (ii) PUSH direct (iii) XCH A, Rn (iv) DAA	(8)
	b)	Explain the addressing modes of 8051.	(6)
		Module 3	
5	a)	Write an ALP to find the sum of an array of 8 bit numbers stored in the	(8)

		external memory of an 8051 microcontroller.	
	b)	How a DAC can be interfaced to 8051? Explain.	(6)
		OR	
6	a)	Write an ALP to add two 16 bit numbers, stored in consecutive locations in the external memory of an 8051 microcontrollers.	(8)
	b)	Explain the interfacing of LCD display with suitable schematic.	(6)
		Module 4	
7	a)	Explain the pin configuration of Arduino MEGA 256 board using a schematic diagram	(14)
		OR	
8	a)	Write short note on open source boards.	(5)
	b)	Explain the working of a four digit 7 segment LED display using an open source board.	(9)
		Module 5	
9	a)	Draw the ARM-7 register architecture and explain.	(7)
	b)	Draw and explain the programming model of an ARM processor.	(7)
		OR	
10	a)	Explain the features of a Raspberry pi -4 board.	(8)
	b)	Explain any one application using Raspberry pi -4 board and draw a schematic.	(6)
		****	

ECT 283	ANALOG COMMUNICATION	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: The course has two objectives: (1) to study two analog modulation schemes known as amplitude modulation and frequency modulation (2) to understand the implementations of transmitter and reciever systems used in AM and FM.

Prerequisite: NIL

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

CO 1	Explain various components of a communication system
CO 2	Discuss various sources of noise, and its the effect in a communication system
CO 3	Explain amplitude modulation and its variants for a sinusoidal message
CO 4	Explain frequency modulation and its variants for a sinusoidal message
CO 5	List and compare various transmitter and receiver systems of AM and FM

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
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Continuous Internal Evaluation Pattern:

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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): Explain various components of a communication system**.**

1. What is the need of a modulator in a radio communcation system?
2. What are the various frequency bands used in radio communication
3. Why base band communication is infeasible for terrestrial air transmission?

Course Outcome 2 (CO2): Discuss various sources of noise, and its the effect in a communication system**.**

1. What is thermal noise?
2. Describe the noise voltage generated across resistor?
3. Why is it that noise voltage can not be used as a source for power?

Course Outcome 3 (CO3): Explain amplitude modulation and its variants for a sinusoidal message**.**

1. Write down the equation for an AM wave for a sinusoidal message
2. What is the significance of modulation index?
3. Describe envelope detector

Course Outcome 4 (CO4): Explain frequency modulation and its variants for a sinusoidal message

4. How is practical bandwidth for an FM wave determined?
5. What are the value of frequency devaiation, bandwidth for a typical FM station?
6. What is PLL?

Course Outcome 5 (CO5): List and compare various transmitter and receiver systems of AM and FM

1. Draw the block diagram of a super heterodyne receiver.
2. How is adjasecent channel rejection achieved in superhet? How is image rejection achieved in a superhet?
3. Explain the working principle of one FM generator, and one FM demodulator.

Syllabus

Module I

Introduction, Elements of communication systems, Examples of analog communication systems, Frequency bands, Need for modulation.

Noise in communication system, Definitions of Thermal noise (white noise), Various types of noise -- Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.

Module II

Brief overview of signals and systems -- Signals, Classification of signals, Energy and power of signals, Basic signal operations, Impulse function, Properties of impulse function, Convolution, LTI system, Fourier Transform, Basic properties, Using Fourier transform to study LTI system.

Module III

Amplitude modulation (AM), Double-side band suppressed carrier (DSB-SC) modulation Single sideband modulation (SSB) – spectrum, power, efficiency of all the three variants. (Study of only tone modulation in DSB-SC, AM, and SSB.) Amplitude-modulator implementations – switching modulator, balanced modulator. AM demodulators -- Coherent demodulator. Envelope detector.

Module IV

Frequency modulation – modulation index, frequency deviation, average power, spectrum of tone modulated FM. Heuristics for bandwidth of FM. Narrow band FM and wide-band FM. FM generation: Varactor diode modulator, Armstrongs method. FM demodulation – slope detection, PLL demodulator.

Module V

Superheterodyne reciever, Principle of Carrier synchronization using PLL, NTSC Television broadcasting.

Text Books

1. Kennedy, Davis, "Electronic Communication Systems," 4th Edition, Tata McGraw Hill

2. Wayne Tomasi, "Electronic Communication Systems – Fundamentals through Advanced," 5th edition, Pearson.

3. B. P. Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, 4th edition, Oxford University Press.

Reference books

1. Leon W. Couch, Digital and Analog Communication Systems, 8th edition, Prentice Hall.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
I	Introduction, Elements of communication systems, Examples of analog communication systems, Frequency bands, Need for modulation	3
	Noise in communication system, Definitions of Thermal noise (white noise), Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.	5
II	**Brief Overview of Signals and Systems:** Signals, Classification of signals, Energy and power of signals, Basic signal operations,	4
	Impulse function, Properties of impulse function, Convolution,	2
	Definition of Linear time-invariant system. Input-output relation of LTI system	2
	Definition of Fourier Transforms, Some Properties of Fourier Transform – Linearity, Time-shift, Modulation theorem, Parsevals theorem. Using Fourier Transform to study LTI systems.	5
III	Amplitude modulation (AM) – modulation index, spectrum, power, efficiency.	2
	Double-side band suppressed carrier (DSB-SC) modulation – spectrum, power, efficiency.	1
	Single sideband modulation (SSB) – spectrum, power, efficiency. (Study of only tone modulation in DSB-SC, AM, and SSB.)	1
	Amplitude-modulator implementations – switching modulator, balanced modulator (at block diagram level).	2
	AM demodulators -- Coherent demodulator. Envelope detector.	3
IV	Frequency modulation – modulation index, frequency deviation, average power, spectrum of tone modulated FM	4
	Heuristics for bandwidth of FM. Narrow band FM and wide-band FM.	1
	FM generation: Varactor diode modulator, Armstrongs method. FM demodulation – slope detection, PLL demodulator.	4

V	Receivers for AM/FM: Super heterodyne receiver (block diagram), Adjacent channel selectivity, Image rejection, Double conversion.	3
	Carrier Synchronization using PLL	1
	NTSC Television broadcasting using AM, FM radio broadcasting.	2

Sample Assignments

1. Using the message signal $m(t)=t/1+t^2$. Determine and sketch the modulated wave for amplitude modulation whose percentage of modulation equal the following values – 50%, 100%, 120%
2. A standard AM transmission sinusoidally modulated to a depth of 30% produces sideband frequencies of 4.98MHz & 4.914 MHz. the amplitude of each sideband frequency is 75V. Determine the amplitude and frequency of the carrier?
3. Write the typical frequency ranges for the following classification of EM spectrum: MF, HF,VHF and UHF.
4. List the basic functions of a radio transmitter and corresponding functions of the receiever?
5. Discuss the types causes and effects of various forms of noise at a receiver.
6. What are the different frequency components in SSB & DSBSC signals?
7. Describe the AM generation using diode as a nonlinear resistor.
8. Define the following terms in the context of FM -- Frequency deviation, frequency sensitivity, instantaneous phase deviation.
9. The equation for FM wave is $s(t)= 10 \cos (2\pi * 10^6 t + 5 \sin(200\pi t + 10 \sin(3000\pi t))$ Calculate frequency deviation, approximate transmission BW and power in the modulated signal.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH. DEGREE EXAMINATION

ECT 283: Analog Communication

Max. Marks: 60 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks each.

1. Explain the need for modulation.
2. A receiver connected to an antenna whose resistance is 50 ohm has an equivalent noise resistance of 30 ohm .calculate receiver noise figure in decibels & its equivalent noise temperature?
3. Plot the signal x(t)=u(t+1)+2u(t)-u(t-3)
4. State Parseval's theorem for DTFT. What is its signifance?
5. Define amplitude modulation? Give the frequency spectrum for AM wave?
6. Derive the expression for total power of AM wave?
7. Explain the following terms a)Modulation index b)Instantaneous frequency deviation
8. Compare AM & FM systems.
9. What are the advantages that the super heterodyne receiver has over the receivers? Are there any disadvantages?
10. Give the limitations of NTSC systems?

PART B

11. (a) Explain the following (i) Thermal noise (ii) Flicker noise (6 marks)
    (b) Explain the elements of communication systems in detail? (8 marks)

OR

12. (a) Define the signal to noise ratio and noise and noise figure of a receiver? How noise temperature related to noise figure? (8 marks)
    (b) List the basic functions of a radio transmitter & the corresponding functions of the receiver? (6 marks)
13. (a) Distinguish between energy & power signals. Give an example for each category? (6 marks)
    (b) State and prove the linearity and time shifting property of Fourier Transform? (8 marks)

OR

14. (a) Check whether the systems are linear & stable. (i) $y(t)=e^{x(t)}$ (ii) y[n]=x[n-1] (6 marks)

    (b) Find convolution of signal x[n] = [1,-1, 1, 1] with itself? (5 marks)
    (c)Distinguish between causal & non causal systems with suitable examples? (3 marks)

OR

15. (a) Derive the expression of total power in SSB wave? (7 marks)

(b) Describe the AM demodulation using envelope detector? (7 marks)

OR

16. (a) Describe the DSB SC wave generation process using balanced modulation (9 marks)

(b) Give the spectrum of SSB & DSB SC waves? Make comparison of bandwidth requirements. (5 marks)

17. (a) Explain the direct method of generating FM signal using varactor diode? (6 marks)

(b) Explain frequency modulation and it average power? (6 marks)

OR

18. (a) Explain with relevant mathematical expressions, the demodulation of FM signal using PLL? (10 marks)

(b) Give the spectrum of tone modulated FM? (4 marks)

19. (a) Explain the super heterodyne receiver with a detailed block diagram? (10 marks)

(b) Explain how the use of RF amplifier & improve the NR of a super heterodyne receiver? (4 marks)

OR

20. (a) Explain the TV broadcasting system using AM? (10 marks)

(b) What is image frequency, how does it arise? (4 marks)

Simulation Assignments

The following simulations can be done in Python/SCILAB/MTLAB or LabVIEW.

Amplitude Modulation Schemes

- Create a sinusoidal carrier($x_c(t)$) and AF signal(x_t) with the frequency of carrier being 10 times that of the AF signal.
- Compute the AM signal as $mx_c(t)x(t) + x_c(t)$ for various values of the modulation index m ranging from 0 to 1.
- Observe the power spectral density of this AM signal.
- $mx_c(t)x(t)$ is the DSB-SC signal. Observe this signal and its power spectral density.
- Load a speech signal in say in *.wav* format into a vector and use it in place of the AF signal and repeat the above steps for a suitable carrier.

SSB Signal Generation

- Simulate an SSB transmitter and receiver using $-\frac{\pi}{2}$ shifters. This can be realized by the Hilbert Transform function in Python, MATLAB etc.
- Test the system with single tone and speech signal.
- Add channel noise to the signal and test for the robustness against noise.
- Slightly offset the receiver carrier phase and observe the effect at the reception.

FM Signal Generation

- Create a sinusoidal carrier($x_c(t)$) and a single tone signal ($x(t)$) with the frequency of carrier being 50 times that of the message tone.
- Compute the FM signal with a modulation index of 5.
- Observe the power spectral density of this FM signal for spectral width of 10 times that tone frequency.

AM Radio Receiver

- Procure a radio kit
- Assemble the kit by soldering all components and enjoy.

FM Radio Receiver

- Procure an FM radio kit
- Assemble the kit by soldering all components and enjoy.

Generation of Discrete Signals

- Generate the following discrete signals
  - Impulse signal
  - Pulse signal and
  - Triangular signal

ECT284	DIGITAL COMMUNICATION	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to apply the concepts of probability and random processes in communication systems.

Prerequisite: ECT 253 Analog communication

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

CO 1	Explain the main components in a digital communication system
CO 2	Explain the source coding schemes
CO 3	Explain codes for signaling
CO 4	Apply the knowledge of digital modulation schemes in digital transmission.
CO 5	Apply channel coding in digital transmission
CO 6	Explain digital receivers

Mapping of course outcomes with program outcomes

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

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): Main components in digital communication system

1. Draw the block diagram of a digital communication system and explain the blocks.
2. Compare and contrast analog communication system with a digital system. List the advantages of the latter.

Course Outcome 2 (CO2): Source Coding

1. Draw the block diagram of a linear PCM system and explain the functions of all blocks.
2. Explain the a-law and mu-law quantization
3. State sampling theorem and explain the reconstruction of signals

Course Outcome 3 (CO3): Signaling Code

1. Explain the principle of alternate mark inversion coding. Give an example with an arbitrary binary data pattern
2. Explain B3ZS code. Give an example with an arbitrary binary data pattern

Course Outcome 4 (CO4): Apply the knowledge of digital modulation schemes in digital transmission.

1. Explain the BPSK transmitter and receiver. Apply its principle to draw the output waveform of a BPSK transmitter that is fed with the bit pattern {1,0,0,1,1,00}.
2. Explain a baseband BPSK system. Give its probability of error. Draw the BER-SNR curve
3. Explain the QPSK transmitter and receiver. Apply its principle to draw the output waveform of a QPSK transmitter that is fed with the bit pattern {1,0,0,1,1,00}.

Course Outcome 5 (CO5): Digital Receivers

1. Explain encoding and decoding with (7,4) block codes
2. Explain the working of a matched filter receiver. Draw the BER-SNR curve at the output.
3. Explain Cyclic codes with an example.

SYLLABUS

Module 1: Linear Source Coding [1]

Elements of digital communication system. Sources, channels and receivers. Classification of communication channels. Discrete sources. Source coding techniques. Waveform coding methods. Sampling theorem. Sampling and reconstruction. Pulse code modulation. Sampling, quantization and encoding. Different quantizers. A-law and mu-law quantization. Practical 15 level mu and A law encoding.

Module 2: Nonlinear Source Coding [1,2]

Differential PCM, adaptive PCM, Delta modulator and adaptive delta modulator. Issues in delta modulation. Slope overload.

Module 3: Signaling Codes in Telephony [1]

Signalling codes in digital telephony. T1 signalling system. AMI and Manchester codes. Binary N-zero substitution, B3ZS code, B6ZS code.

Module 4: Digital Modulation Schemes [1,2]

Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK transmitter and receiver. Base band QPSK system and Signal constellations. Plots of BER Vs SNR (Analysis not required). QPSK transmitter and receiver. Quadrature amplitude modulation.

Module 5: Channel Coding and Receivers [1,2]

Transmission through AWGN Channel. Capacity of an AWGN channel. Receivers. Correlation and matched filter receiver. Channel coding schemes. Repetition code. Block codes Cyclic codes.

Text Books

1. John C. Bellamy, "Digital Telephony",Wiley
2. Simon Haykin, "Communication Systems", Wiley.
3. Sklar, "Digital Communications: Fundamentals and Applications", Pearson.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Linear Source Coding**	
1.1	Block diagram of digital communication system, Sorces, channel and receivers. Classification of Channels	2
1.2	Source coding , waveform coding , sampling and reconstruction	2
1.3	PCM, Compression, 15 level A and mu-law coding	4
1.4	Uniform and Gaussian Pdf and correspoding CDF. Properties	1
2	**Nonlinear Source Coding**	
2.1	DPCM,Adaptive DPCM	4
2.2	Delta modulation, slope overload	3
3	**Signaling Codes**	
3.1	Overview of T1 signaling systems. Need for signaling codes, AMI and Manchestre codes	4
3.2	Binary N-zero substitution, B3ZS code, B6ZS code	3
3.5	Mutual information and channel capacity. Capacity of AWGN channel	2
4	**Digital Modulation**	
4.1	Need of digital modulation in modern communication.	1
4.2	Baseband BPSK system, signal constellation. Effect of AWGN, probability of error. BER-SNR curve, BPSK transmitter and receiver.	4
4.3	Baseband QPSK system, signal constellation. Effect of AWGN, probability of error. BER-SNR curve, QPSK transmitter and receiver.	4
4.4	QAM system	2
5	**Channel Coding and Receivers**	
5.1	Mutual information and channel capacity	2
5.2	Correlation and matched filter receiver, BER-SNR curve	2
5.3	Channel coding schemes. Repetition code. Block codes. Cyclic codes	5

Simulation Assignments

The following simulations can be done in MATLAB, Python,R or LabVIEW.

A-Law and μ-Law Characteristics

- Create a vector with say 1000 points that spans from -1 to 1.
- Apply A-Law companding on this vector get another vector. Plot it against the first vector for different A values and appreciate the transfer characteristics.
- Repeat the above steps for μ-law as well.

Practical A-Law compander

- Implement the 8-bit practical A-law coder and decoder in Appendix B 2 (pp 583–585) in *Digital Telephony by Bellamy*
- Test it with random numbers and speech signals. Observe the 15 levels of quantization.

Practical μ-Law compander

- Implement the 8-bit practical μ-law coder and decoder in Appendix B 1 (pp 579–581) in *Digital Telephony by Bellamy*
- Test it with random numbers and speech signals. Observe the 15 levels of quantization.

B3ZS Encoder and Decoder

- Implenet a B3ZS encoder and decoder.
- Test it with random bits.
- Decode and compare the result with the original bit pattern.

B6ZS Encoder and Decoder

- Implenet a B6ZS encoder and decoder.
- Test it with random binary vector.
- Decode and compare the result with the original bit pattern.

Base Band BPSK System

- Cretae a random binary sequence of 5000 bit. Convert it into a bipolar NRZ code.
- Create a BPSK mapper that maps bit 0 to zero phase and bit 1 to π phase.
- Plot the real part of the mapped signal against the imaginary part to observe the signal constellation
- Add AWGN of difference variances to the base band BPSK signal and observe the changes in constellation.
- Realize the BPSK transmitter and receiver in Fig. 6.4 in pager 352 in *Communication Systems by Simon Haykin* .
- Add AWGN of different variances and compute the bit error rate (BER) for different SNR values.
- Plot the BER Vs. SNR.
- Plot the theoretical BER-SNR curve, using Eq. 6.19 in pager 351 in *Communication Systems by Simon Haykin* .

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Course: ECT 284 Digital Communication

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

PART A

Answer All Questions

1	State sampling theorem	(3)	K_2
2	Give the classification of communication channels	(3)	K_2
3	Explain the term slope overload	(3)	K_2
4	Why is a logarithmic quantizer preferred in DPCM?	(3)	K_2
5	Explain the needs for signalling codes	(3)	K_1
6	Draw the Manchester code for the bit pattern $\{1, 0, 1, 1, 0, 0\}$	(3)	K_3
7	Draw the BER-SNR curve for a BPSK system	(3)	K_2
8	Draw the signal constellation for a baseband QPSK system	(3)	K_2
9	Define mutual information and channel capacity	(3)	K_2
10	Explain a (7,4) block code.	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Draw the block diagram of a linear PCM system and explain the blocks	(8)	K_2
11(B)	Explain μ-law companding	(6)	K_2

OR

12(A)	Explain how companding is achieved practically using different levels	(8)	K_2

12(B)	Explain mid-rise and mid-tread quantizers	(6)	K_2

Module II

13(A)	Explain the need for differential PCM. What is the advantage over linear PCM	(6)	K_2
13(B)	Draw the block diagram of a DPCM transmitter and receiver and explain the functions of ech block.	(8)	K_3

OR

14(A)	Draw the block diagram of a delta modulator and explain the functions of each block	(8)	K_2
14(B)	Explain the principle of adaptive delta modulation	(6)	K_2

Module III

15(A)	What is binary zero substitution? Explain the B3ZS line coding scheme	(8)	K_2
15(B)	Encode {101000010000000001} using B3ZS code	(6)	K_3

OR

16(A)	Explain the principle of alternate mark inversion coding. Give an example with an arbitrary binary data pattern	(8)	K_2
16(B)	Encode {101000010000000001} using B6ZS code	(6)	K_3

Module IV

17(A)	Draw the block diagram of BPSK transmitter and receiver and explain the functions of each block. Draw the BER-SNR curve.	(8)	K_2
17(B)	Draw the signal constellation of base band BPSK and indicate the effect of AWGN on it	(6)	K_2

OR

18(A)	Draw the block diagram of QPSK transmitter and receiver and explain the functions of each block. Draw the BER-SNR curve.	(8)	K_2
18(B)	Explain the QAM modulation and demodulation.	(6)	K_2

Module V

19(A)	Explain how matched filter is used in digital reception? Draw the BER-SNR curve at the output.	(8)	K_3
19(B)	Explain how correlation receiver is used in digital reception?	(6)	K_3

OR

20	Explain channel encoding and decoding with (7,4) block codes	(14)	K_3

ECT285	INTRODUCTION TO SIGNALS AND SYSTEMS	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to apply the concepts of electrical signals and systems

Prerequisite: None

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

CO 1	Define and classify continuous and discrete signals
CO 2	Explain and characterize a system and LTI system
CO 3	Explain the spectrum of a signal

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

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): Definition and classification of signals

1. Define a signal. Classify them to energy and power signals.
2. Determine whether the signal x(t)=cos(3t)+sin(5t) is periodic. If so what is the period?
3. Compare the frequency range of continuous time and discrete signals.

Course Outcome 2 (CO2): Explain and characterize a system

1. Check whether the system y[n]=cos{x[n]}is a. Stable b. Causal c. time invariant d. linear
2. Derive the ouptut of a continuous time LTI system
3. Give the meaning of impulse response of LTI systems

Course Outcome 2 (CO3): Spectra of Signals

1. State and prove Parsevals theorem
2. State and prove the modulation property of Fourier transform
3. Find the continuous tiime Fourier transform a pulse of width w and amplitude unity and centred about the origin.

Syllabus

Module 1 : Introduction to Continuous Time Signals

Definition of signal. Basic continous-time signals. Frequency and angular frequency of continous-time signals . Basic operation on signals. Classification of continous-time signals:Periodic and Non-periodic signals.Even and Odd signals, Energy and power signals. Noise and Vibration signals.

Module 2 : Discrete Time Signals

Basic discrete-time signals. Frequency and angular frequency of discrete-time signals.Classification of discrete-time signals:Periodic and Non-periodic signals.Even and Odd signals, Energy and power signals.

Module 3: Systems

System definition. Continuous-time and discrete-time systems. Properties – Linearity, Time invariance, Causality, Invertibility,Stability. Representation of systems using impulse response.

Module 4: Linear time invariant systems

LTI system definition. Response of a continous-time LTI system and the Convolutional Integral. Properties. Response of a discrete-time LTI system and the Convolutional Sum. Properties. Correlation of discrete-time signals

Module 5 : Frequency analysis of signals

Concept of frequency in continous-time and discrete-time signals. Fourier transform of continuous-time and discrete-time signals. Parsevals theorem. Interpretation of Spectra. Case study of a vibration signal.The sampling theorem.

Text Books

1. Simon Haykin, Barry Van Veen, Signals and systems, John Wiley
2. Hwei P.Hsu, Theory and problems of signals and systems, Schaum Outline Series, MGH.
3. Anders Brandt, Noise and Vibration Analysis,Wiley publication.
4. A Anand Kumar, Signals and systems, PHI learning
5. Sanjay Sharma, Signals and systems

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Continuous Time Signals**	
1.1	Definition of signal, Basic continous-time signals.	3
1.2	Frequency and angular frequency of continous-time signals	1
1.3	Basic operation on signals	1
1.4	Classification of continous-time signals	3
1.5	Noise and Vibration signals	1
2	**Discrete Time Signals**	
2.1	Basic discrete-time signals and its frequency	3
2.2	Classification of discrete-time signals	3

3	**Systems**	
3.1	System definition- CTS & DTS	1
3.2	Properties-Linearity, Time invariance	3
3.3	Causality, Invertibility, Stability	2
3.4	Representation of systems using impulse response	1
4	**Linear time invariant systems**	
4.1	LTI system definition.Properties.	1
4.2	Response of a continuous-time LTI system and the Convolutional Integral	3
4.3	Response of a discrete-time LTI system and the Convolutional Sum	3
4.4	Correlation of discrete-time signals	2
5	**Frequency analysis of signals**	
5.1	Concept of frequency in continuous-time and discrete-time signals	1
5.2	CTFT and spectra	3
5.3	DTFT and spectra	3
5.4	DFT	1
5.5	Parsevals theorem	1
5.6	Case study of a vibration signal	1
5.7	The sampling theorem	2

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

ECT 285 Introduction to Signals and Systems

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

PART A

Answer All Questions

1	Differentiate between energy and power signal with example.	(3)	K_2
2	Find the even and odd components of $x(t) = e^{jt}$.	(3)	K_2
3	Define discrete time signal and comment about its frequency range.	(3)	K_2
4	Sketch the sequence $x(n) = 2\delta(n-3) - \delta(n-1) + \delta(n) + \delta(n+2)$.	(3)	K_2
5	State and explain BIBO condition for system.	(3)	K_1
6	Distinguish between continuous time and discrete time systems.	(3)	K_2
7	Derive a relationship between input and output for a discrete LTI system	(3)	K_2
8	Compute the energy of the signal $x(n) = 0.8^n u(n)$	(3)	K_2
9	State and explain sampling theorem.	(3)	K_2
10	Comment about the input output characteristics of continuous time Fourier transform	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

11(A)	Determine whether or not the signal $x(t) = \cos t + \sin\sqrt{2}t$ is periodic. If periodic determine its fundemental period.	(7)	K_2
11(B)	Define, sketch and list the properties of continuous time impulse function	(7)	K_2

OR

12(A)	Determine whether the signal $x(t) = e^{-2t}u(t)$ is energy signal, power signal or neither.	(7)	K_2
12(B)	Define unit step function and plot $u(t+2) - u(t-2)$.	(7)	K_2
13(A)	Given the sequence $x(n) = \{1, 2, 1, 1, 3\}, -1 \leq n \leq 3$. Sketch • $x(-n+2)$ • $x(n/2)$	(8)	K_3
13(B)	Show that any signal $x(n)$ can be represented as the summation of an even and odd signal.	(6)	K_2

OR

14	Discuss briefly the basic discrete time signals.	(14)	K_2
15(A)	Explain linear and nonlinear systems.	(6)	K_2
15(B)	Apply the properties of system to check whether the following systems are linear or nonlinear • $y(t) = tx(t)$ • $y(n) = x^2(n)$	(8)	K_3

OR

16(A)	A sytem has an input-output relation given by $y(n) = T\{x(n)\} = nx(n)$. Determine whether the system is a)Memoryless b)Causal c) Linear d) Time invariant e)Stable	(14)	K_3

17	The impulse response of a linear time invariant system is $h(n) = \{1, 2, 1, -1\}, -1 \leq n \leq 2$ Determine the response of the system for the input signal $x(n) = \{1, 2, 3, 1\}$	(14)	K_3

OR

18	A system is formed by connecting two systems in cascade. The impulse response of the system is given by $h_1(t)$ and $h_2(t)$ respectively where $h_1(t) = e^{-2t}u(t)$ and $h_2(t) = 2e^{-t}u(t)$ a)Find overall impulse response h(t) of the system. b) Determine the stability of the overall system	(14)	K_3
19(A)	Find the Nyquist rate of $x(t) = sin400\pi t + cos500\pi t.$	(7)	K_2
19(B)	State and prove modulation property of Fourier Transform	(7)	K_2

OR

20(A)	Find the CTFT of the signal $x(t) = te^{-at}u(t)$	(7)	K_2
20(B)	State and prove Parsevals theorem	(7)	K_2

Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/OCTAVE

1. Generate the following discrete signals
   - Impulse signal
   - Pulse signal and
   - Triangular signal
2. Write a function to compute the DTFT of a discrete energy signal. Test this function on a few signals and plot their magnitude and phase spectra.
3. - Compute the linear convolution between the sequences $x = [1, 3, 5, 3]$ with $h = [2, 3, 5, 6]$. Observe the stem plot of both signals and the convolution.
   - Now let $h = [1, 2, 1]$ and $x = [2, 3, 5, 6, 7]$. Compute the convolution between h and x.
   - Flip the signal x by $180°$ so that it becomes $[7, 6, 5, 3, 2]$. Convolve it with h. Compare the result with the previous result.
   - Repeat the above two steps with $h = [1, 2, 3, 2, 1]$ and $h = [1, 2, 3, 4, 5, 4, 3, 2, 1]$
   - Give your inference.
4. - Write a function to generate a unit pulse signal as a summation of shifted unit impulse signals
   - Write a function to generate a triangular signal as a convolution between two pulse signals.
5. - Relaize a continuous time LTI system with system response

   $$H(s) = \frac{5(s+1)}{(s+2)(s+3)}$$

   . One may use *scipy.signal.lti* package in Python.
   - Make it into a discrete system (possibly with *scipy.signal.cont2discrete*)
   - Observe the step response in both cases and compare.

ECT286	INTRODUCTION TO DIGITAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to give an introduction to digital signal processing

Prerequisite: ECT255 Introduction to Signals and Systems

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

CO 1	Explain how digital signals are obtained from continuous time signals.
CO 2	Apply Fourier transform in the analysis of signals
CO 3	Implement digital filters
CO 4	Explain the practical limitations in DSP implementations
CO 5	Explain the structure of a DSP processor.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	25	25	50
Apply	15	15	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): Discrete Signals and Sampling Theorem

1. Define a digital signal. Give the frequency range of digital signal. Explain the sampling theorem and show graphically how samples are generated from a continuous time signal.

2. What should be the minimum frequency to sample a 2.5kHz analog signal? Explain graphically how the continuous time signal is reconstructed from samples.

Course Outcome 2 (CO2): Application of Fourier Transform

1. Give the expression for DFT of an N-point sequence. Compute the 10 point DFT of a unit impulse sequence.

2. Derive the raddix-2 decimation in time algorithm for N=8.

Course Outcome 3 (CO3): Implementation of Digital Filters

1. Give the difference equation of an IIR filter. Give an example and draw its structure

2. Design an IIR Butterworth filter for passband frequency 5kHz and stopband frequency 10kHz. The stop band and passs band attenuations are 0.1 respectively.

Course Outcome 4 (CO4): Practical Limitations of Digital Filters

1(A). Explain the limit cycle oscillations in IIR filters

(B) Explain the effects of coefficient quantization in IIR filters

2. (A) Explain the effects of round of noise in digital filters
2(B) Explain the fixed and floating point arithmetic used in DSP processors.

Course Outcome 5 (CO5): Structure of Digital Signal Processors

1(A). Explain the function of the MAC unit in a DSP

(B) Explain the differences between Harvard and Von Neumann architecture.

2. Draw the internal structure of a floating point processor and explain its functional blocks

Syllabus

Module 1: Signal Processing Fundamentals
Discrete-time and digital signals. Basic elements of digital processing system- ADC, DAC and Nyquist rate. Frequency aliasing due to sampling. Need for anti-aliasing filters. Discrete Time Fourier Transforms – Properties. Computation of spectrum.

Module 2: Discrete Fourier Transform – Properties and Application
Discrete Fourier transform - DFT as a linear transformation, Properties - circular convolution. Filtering of long data sequences - FFT-Radix-2 DIT and DIF algorithms. Computational complexity of DFT and FFT -application.

Module 3: Digital Filters
Digital FIR Filter: Transfer function - Difference equation, Linear phase FIR filter, Concept of windowing, Direct form and cascade realization of FIR and IIR filters. Digital IIR Filters - Transfer function, Difference equation. Direct and parallel Structures. Design of analogue Butterworth filters, Analog frequency transformations, Impulse invariance method. Bilinear transformation, Analog prototype to digital transformations.

Module 5: Finite word length effects in digital filters and DSP Hardware
Fixed point arithmetic, Floating point arithmetic, Truncation and Rounding, Quantization error in ADC, Overflow error, Product round off error, Scaling , Limit cycle oscillation.

General and special purpose hardware for DSP: Computer architectures for DSP – Harvard, pipelining, MAC, special instruction, replication, on chip cache. General purpose digital signal processors (TMS 320 family) - Implementation of digital filtering on dsp processor. Special purpose DSP hardware

Text Books
1. Proakis, J.G. & Manolakis, D.G., “Digital Signal Processing: Principles, Algorithms,& Applications”, 3/e Prentice Hall of India, 1996.
2. Ifeachor, E.C., & Jervis, B.W., “Digital Signal Processing: A Practical Approach”,2/e, Pearson Education Asia, 2002.
3. Chen, C.T., “Digital Signal Processing: Spectral Computation & Filter Design”, Oxford Univ. Press, 2001.
4. Mitra, S.K., “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, NY, 1998
5. Monson H Hayes, Schaums outline: Digital Signal Processing.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Signal Processing Fundamentals**	
1.1	Overview of signals. Frequency elements of DSP sytems	2
1.2	Conversion of analog signals to digital signals, Sampling theorem, reconstruction ADC and DAC , spectra and antialiasing filter	3
1.3	DTFT properties, spectrum	3

2	**DFT**	
2.1	DFT from DTFT, DFT as a linear transformation. W matrix. Properties of DFT, Computational challenges.	3
2.2	FFT for comptational advantage, Radix -2 DIT and Dif algorith, in place computation. Bit reversal permutation. complexity	4
2.3	Filtering of long sequences	2
3	**Digital Filters**	
3.1	Model of FIR and IIR filters. Direct form I and II of FIR filter, simple FIR design	4
3.2	IIR filter, design of Butterworth filter, Direct and parallel realization	4
3.3	Analog to digital transformation, impulse invariance and bilinear transformation.	4
4	**Finite Word-length Effects**	
4.1	Number representation Truncation - Rounding - Quantization error in ADC - Overflow error- product round off error - Scaling - Limit cycle oscillation.	2
4.2	Truncation-Rounding - Quantization error in ADC - Overflow error - product round off error - Scaling - Limit cycle oscillation.	5
5	**DSP Architecture**	
5.1	Von Neumann and Harvard architecture, Comparison	1
5.2	Data paths of fixed and floating point DSP processors. Functions of various blocks Architecture of a typical DSP processor	5
5.3	Implementation of systems on DSP chip	2

Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/OCTAVE

1. Generate the following discrete signals
   - Impulse signal
   - Pulse signal and
   - Triangular signal
2. Write a function to compute the DFT of a discrete energy signal. Test this function on a few signals and plot their magnitude and phase spectra.
3. - Compute the linear convolution between the sequences $x = [1, 3, 5, 3]$ with $h = [2, 3, 5, 6]$. Observe the stem plot of both signals and the convolution.
   - Now let $h = [1, 2, 1]$ and $x = [2, 3, 5, 6, 7]$. Compute the convolution between h and x.
   - Flip the signal x by $180°$ so that it becomes $[7, 6, 5, 3, 2]$. Convolve it with h. Compare the result with the previous result.
   - Repeat the above two steps with $h = [1, 2, 3, 2, 1]$ and $h = [1, 2, 3, 4, 5, 4, 3, 2, 1]$
   - Give your inference.
4. - Compute the DFT matrix for $N = 8, 16, 64, 1024$ and 4098
   - Plot the first 10 rows in each case and appreciate these basis functions
   - Plot the real part of these matrices as images and appreciate the periodicities and half periodicities in the pattern
   - Normalize each matrix by dividing by $\sqrt{N}$. Compute the eigenvalues of every normalized matrix and observe that all eigenvalues belong to the set $\{1, j, -j, -1\}$.
5. - Realize a continuous time LTI system with system response

     $$H(s) = \frac{5(s+1)}{(s+2)(s+3)}$$

     . One may use *scipy.signal.lti* package in Python.
   - Make it into a discrete system (possibly with *scipy.signal.cont2discrete*)
   - Observe the step response in both cases and compare.
6. - Download a vibration signal in *.wav* format.
   - Load this signal into an array. One may use the *scipy.io.wavfile* module in Python.
   - understand the sampling rate of this signal.

- Plot and observe the vibration signal waveform.
- Compute the absolute squared value of the FFT of the vibration signal.
- Plot it and observe the spectral components in the discrete frequency domain.
- Multiply prominent discrete frequencies by the sampling rate and observe and appreciate the major frequency components in Hz.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B. Tech. Degree Examination

Branch: Electronics and Communication

Course: ECT 286 Introduction to Digital Signal Processing

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

PART A

Answer All Questions

1	Define frequency of a discrete signal and identify its range.	(3)	K_1
2	State Nyquist sampling theorem for low pass signals and the formula for signal reconstruction.	(3)	K_3
3	Explain why DFT operation is a linear transformation.	(3)	K_2
4	Explain how FFT reduces the computational complexity of DFT.	(3)	K_2
5	Write the expresssion for the Hamming window and plot it.	(3)	K_1
6	Give the expression for bilinear tranformation and explain the term frequency warping.	(3)	K_2
7	Explain the quantization error in ADCs.	(3)	K_2
8	Explain the 1s and 2s complement representation of numbers in DSP processor.	(3)	K_2
9	Compare floating point and fixed point data paths in a DSP processor.	(3)	K_2
10	Explain function of a barrel shifter in a DSP processor.	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Explain how analog signals are converted to digital signals.	(10)	K_2
11(B)	What all digital frequencies are obtained when a $1\,kHz$ signal is sampled by $4\,kHz$ and $8\,kHz$ impulse trains?	(4)	K_3

OR

12(A)	Give the expression for DTFT. Compute the DTFT of the signal $x[n] = [1, -1, 1, -1]$	(8)	K_3
12(B)	Explain how sampling affects the spectrum of the signal and the need of antialiasing filter	(6)	K_3

Module II

13(A)	Give the radix-2 decimation in time algorithm for 8-point FFT computation	(10)	K_3
13(B)	How is in place computation applied in FFT algorithms?	(4)	K_3

OR

14(A)	Find the DFT of the sequence $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using radix-2 DIF algorithm	(10)	K_3
14(B)	How is bit reverse addressing used in FFT computations?	(4)	K_3

Module III

15(A)	Write the difference equation representation of IIR filter and explain how its impulse response is infinite in duration	(7)	K_3

15(B)	Convert the analog filter $$H(s) = \frac{1}{(s+1)(s+2)}$$ into digital filter using impulse invariance method.	(7)	K_3

OR

16(A)	Implement the FIR filter $h[n] = [1, 2, 4, 6, 4, 2, 1]$ with minimum multipliers in directform	(6)	K_3
16(B)	Design an IIR Butterworth filter for passband frequency $5\,kHz$ and stopband frequency $10\,kHz$. The stop band and passs band attenuations are 0.1 respectively.	(8)	K_3

Module IV

17(A)	Explain the limit cycle oscillations in IIR filters	(6)	K_3
17(B)	Derive the quantization noise power in an ADC	(8)	K_3

OR

18(A)	Find the output noise variance of a first order system with transfer function $$H(z) = \frac{1}{1-\alpha z^{-1}}$$ that is driven by a zero mean white Gaussian noise of variance σ_N^2	(8)	K_3
18(B)	Explain the fixed and floating point arithmetic used in DSP processors.	(6)	K_3

Module V

19	Draw and explain the functional blocks in a floating point DSP processor.	(14)	K_2

OR

20(A)	Compare Von Neumann architecture with Harvard architecture	(7)	K_2
20(B)	Explain the significance and operation of the MAC unit in a DSP processor	(7)	K_2

ECT381	EMBEDDED SYSTEM DESIGN	CATEGORY	L	T	P	CREDI T
		PCC	3	1	0	4

Preamble: This course aims to design an embedded electronic circuit and implement the same.

Prerequisite: ECT203 Logic Circuit Design, ECT206 Computer Architecture and Microcontrollers

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

CO 1 K2	Understand and gain the basic idea about the embedded system.
CO 2 K3	Able to gain architectural level knowledge about the system and hence to program an embedded system.
CO 3 K3	Apply the knowledge for solving the real life problems with the help of an embedded system.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
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 embedded system fundamentals and system design (K1).

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): To write programs using high level languages for embedded systems. (K3)

1. Write an embedded C program for sorting 64 numbers stored in memory locations and find the smallest and largest number.
2. How the functions are called by using pointers in embedded ‘C’ ? Discuss with the help of examples.
3. Give the features of Object Oriented Programming.

Course Outcome 4 (CO4): To understand the ARM processor architecture and pipeline processor organization. (K2)

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

Course Outcome 5 (CO5): 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.

SYLLABUS

Module 1 : Introduction to Embedded Systems(08 Hours)

1.1 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

1.2 The Embedded System Design Process

Requirements, Specification , Architecture Design, Designing Hardware and Software Components and System Integration.

1.3 Formalisms for System Design

Structural Description, Behavioral Description, An embedded system design example.

1.4 Embedded product development cycle (EDLC)

Different phases of EDLC and EDLC models

Module 2 : Embedded system interfacing and peripherals (09Hours)

2.1 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.

2.2 Memory

Memory devices and systems :– ROM-Flash, EEPROM: RAM-SRAM, DRAM, Cache memory, memory mapping and addresses, memory management unit– DMA .

2.3 I/O Device

Interrupts:-Interrupt sources, recognizing an interrupt, ISR – Device drivers for handling ISR, Shared data problem, Interrupt latency.

Module 3 : Embedded Programming(11 Hours)

3.1 Programming languages:- Assembly Languages, High level languages, Embedded C, Object oriented programming, C++, JAVA.
3.2 Embedded C programming:- Keywords and Identifiers, Data Types, Storage Class, operators, branching, looping, arrays, pointers, characters, strings, functions, function pointers, structures, unions, pre-processors and macros, constant declaration, volatile type qualifier, delay generation, infinite loops, bit manipulation, ISR, direct memory allocation

Module 4 : ARM Processor fundamentals (07 Hours)

4.1 ARM Processor architecture:-The Acorn RISC Machine- Architectural inheritance, The ARM programmer's model, ARM development tools.
4.2 ARM Assembly Language Programming:-Data processing instructions, Data transfer instructions, Control flow instructions, writing simple assembly language programs.
4.3 ARM Organization and Implementation:-3 stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface

Module 5: ARM Programming (10 Hours)

5.1 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.
5.2 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.
5.3 Architectural Support for System Development:- The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA).

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

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Embedded Systems**	
1.1	Complex Systems and Microprocessors	3
1.2	The Embedded System Design Process	1
1.3	Formalisms for System Design	2
1.4	Embedded product development cycle (EDLC)	2
2	**Embedded system interfacing and peripherals**	
2.1	Communication devices	3
2.2	Memory	3
2.3	I/O Device	3
3	**Embedded Programming**	
3.1	Programming languages	1
3.2	Embedded C programming	10
4	**ARM Processor**	
4.1	ARM Processor architecture	2
4.2	ARM Assembly Language Programming	3
4.3	ARM Organization and Implementation	2
5	**ARM Programming**	
5.1	Architectural Support for High-Level Languages	4
1	The Thumb Instruction Set	4
5.3	Architectural Support for System Development	2

Simulation Assignments:

1. At least one assignment should be of programming (Both assembly and C languages) of embedded processor with simulation tools like Keil, Eclipse.
2. Another assignment should be an embedded system design mini project like, Programming assignments can be the following
   a) Print "HELLO WORLD" or any text, b)Data transfer, copy operations c)Arithmetic operations d)Sorting operations, e)Input/output control, f)Programs using functions, g) Interrupts and ISR h) controller design
3. Mini project can be done in the following areas.
   a) Elevator controller design (b) Chocolate vending machine design (c) Industrial controller using sensors (d) IOT applications using sensors, communication devices and actuators

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT381

Course Name: EMBEDDED SYSTEM DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer for all questions. Each Question Carries 3 marks)

1. Define an embedded system
2. Write any three challenges of embedded system design
3. Explain how an RS232 device is interfaced to a processor
4. What is interrupt latency?
5. What are the differences between assembly level language and high level language?
6. What is the difference between macros and functions?
7. Write the contents of CPSR register of ARM processor and their use.
8. Draw the five stage pipeline architecture of ARM processor
9. What is the use of thumb instruction set in ARM processor?
10. Write a note on ARM memory interface. [10 X 3 = 30 Marks]

PART – B

(Answer one question from each module; each question carries 14 Marks)

Module – I

11. a). What are the characteristics of an embedded system? Explain. [07 Marks]
b). Explain the different phases of EDLC. [07 Marks]

OR

(a) Write different steps involved in the embedded system design process. [07 Marks]
(b) Explain the structural description of embedded system design. [07 Marks]

Module – II

12. (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

13. (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]

Module – III

14. (a) What are the advantages and disadvantage of object oriented programming like C++ and Java. [07 Marks]
(b) Write an embedded C program for adding 64 numbers stored in memory locations and find the average of the same. [07 Marks]

OR

15. (a) What is pre-processor directive? How is a pre-processor directive instruction differentiated from normal program code? What are the different types of pre-processor directives available in 'Embedded C'? [07 Marks]
(b) Write an embedded C program to perform addition, subtraction, multiplication and division operations of 2 numbers stored in specific memory locations using a mode control . [07 Marks]

Module – IV

16. (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

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

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

Module – V

18. (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

19. (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 this architecture? [07 Marks]

ECT382	VLSI CIRCUITS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to impart the knowledge about the fundamentals of Digital Systems, MOSFETs, basic VLSI circuits and Application Specific Integrated Circuits.

Prerequisite: ECT281 Electronic Circuits

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

CO1	Explain the working of various functional building blocks used in digital system design
CO2	Explain Structure and working of MOSFETS and basic VLSI circuits using MOSFET
CO3	Explain the circuit technique used to implement dynamic logic and storage cells
CO4	Explain the application specific integrated circuit design flow and design approached
CO5	Explain the programmable logic cells, programming technologies, different type of i/o cells and different timing constraints in ASIC design

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3								2	3
CO2	3	2	2		1							3
CO3	3	2	2		1							3
CO4	3	3	3		3						3	3
CO5	3	3	3		3						3	3

Assessment Pattern:

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	15	15	30
Understand	K2	25	25	50
Apply	K3	10	10	20
Analyse				
Evaluate				
Create				

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	50	100	3Hrs

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern

Maximum Marks: 100 **Time: 3 hours**

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. Mark patterns are as per the syllabus with 75% for theory and 25% for logical/numerical problems.

Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. With circuit and truth table, explain the working of a full adder.
2. Explain the use of 2m:1 multiplexer for realizing a logic function od m variables.
3. With circuit and truth table, explain the working of a 4 bit ripple counter

Course Outcome 2 (CO2):

1. Draw the stricture of a n-channel MOSFET and describe its working
2. Explain the static characteristics of NMOS inverter and derive its pull up to pull down impedance ratio
3. Draw the circuit diagram of two input NAND gate in CMOS logic and represent it using its stick diagram

Course Outcome 3 (CO3):

1. Describe the basic principle of dynamic logic with necessary diagrams
2. Explain the working of np domino logic. What is its merits and demerits over domino logic?
3. Explain the working of one transistor Dynamic Memory Cell.

Course Outcome 4 (CO4):

1. Explain and compare the full custom and semicustom IC design methods
2. Describe the Top-Down and Bottom-Up design methodologies using in ASIC design
3. Discuss the Speed power and area considerations in VLSI design

Course Outcome 5 (CO5):

1. Explain a multiplexer based programmable logic cells
2. Describe the programmable array based logic implementation in Altera MAX
3. Define setup time, hold time, propagation delay, clock to output delay

Syllabus

Module 1: Basic Building Blocks in Digital Systems (12 Hrs)

Basic logic gates, binary adder, subtractor, magnitude comparator, decoders, encoders, multiplexers, simple examples for combinational circuits (discuss with respective truth tables) Sequential circuits, Latched and flip-flops, clocked sequential circuits, registers, shift registers, counters (analysis not required)

Module 2: MOSFET Fundamentals and basic VLSI circuits (9 Hrs)

Structure and working principle of MOSFETS, VI characteristics, current equations(derivations not required),
NMOS and CMOS inverter circuits, static characteristics and comparison, implementation of CMOS logic gates, stick diagram representation, Layout Design and Design rules- Lambda rules and micron rules (Definitions only).

Module 3: Dynamic logic Design and Storage Cells (8 Hrs)

Dynamic Logic Design-Pre charge- Evaluate logic, Domino Logic, NP domino logic. Read Only Memory-4x4 MOS ROM Cell Arrays (NOR) Random Access Memory –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell.

Module 4: VLSI Design Methodologies (7 Hrs)

Introduction: Moore slaw .ASIC design, Full custom ASICs, Standard cell based ASICs, Gate array based ASICs, SoCs, FPGA devices, ASIC and FPGA Design flows Top-Down and Bottom-Up design methodologies. Logical and Physical design. Speed power and area considerations in VLSI design

Module 5: FPGA Architecture(8 Hrs)

Programmable logic cells: multiplexer based logic cells(ACT1), lookup table based logic implementation(XC3000 CLB), programmable array based logic implementation (Altera MAX).
ASIC programming technologies: antifuse, SRAM, EPROM, EEPROM
Different types of I/O cells used in programmable ASICs

Timing constraints in ASIC design: setup time, hold time, propagation delay, clock to output delay, critical path (concept only)

Text Books:

1. M. Morris Mano, Digital Design 3/e, Prentice Hall of India, 2002.
2. M. J. S. Smith, Application Specific Integrated Circuits, Pearson Education,2007
3. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003

References:

1. Thomas Floys, Digital Fundamentals, 11th edition, Pearson Publication, 2015
2. Neil H.E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005.
3. Jan M. Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005.

Course Contents and Lecture Schedule

No	Topic	No. of. Lectures
Module 1: Basic Building Blocks in Digital Systems (12 hours)		
1.1	Basic logic gates,	**1**
1.2	binary adder, subtractor	**2**
1.3	magnitude comparator, decoders, encoders	**1**

1.4	multiplexers, simple examples for combinational circuits	**2**
1.5	Sequential circuits, Latches and flip-flops	**2**
1.6	clocked sequential circuits, registers, shift registers, counters	**4**
Module 2: MOSFET Fundamentals and basic VLSI circuits (9 hours)		
2.1	Structure and working principle of MOSFETS	**1**
2.2	VI characteristics, current equations	**1**
2.3	NMOS and CMOS inverter circuits, static characteristics and comparison	**3**
2.4	Implementation of CMOS logic gates	**2**
2.5	Stick diagram representation, Layout Design and Design rules- Lambda rules and micron rules (Definitions only)	**2**
Module 3: Dynamic logic Design and Storage Cells (7 hours)		
3.1	Dynamic Logic Design-Pre charge- Evaluate logic	**1**
3.2	Domino Logic, NP domino logic	**2**
3.3	ROM, Ram and DRAM	**4**
Module 4: VLSI Design Methodologies. (8 hours)		
4.1	Introduction: Moore slaw .ASIC design,	**1**
4.2	Full custom ASICs, Standard cell based ASICs, Gate array based ASICs, SoCs, FPGA devices	**3**
4.3	ASIC and FPGA Design flows Top-Down and Bottom-Up design methodologies.	**2**
4.4	Logical and Physical design. Speed power and area considerations in VLSI design	**2**
Module 5: FPGA Architecture (9 hours)		
5.1	Programmable logic cells: multiplexer based logic cells(ACT1), lookup table based logic implementation(XC3000 CLB), programmable array based logic implementation (Altera MAX).	**3**
5.2	ASIC programming technologies: antifuse, SRAM, EPROM, EEPROM	**2**
5.3	Different types of I/O cells used in programmable ASICs	**2**
5.4	Timing constraints in ASIC design: setup time, hold time, propagation delay, clock to output delay, critical path	**2**

Model Question Paper

A P J Abdul Kalam Technological University

Sixth Semester B Tech Degree Examination

Course: **ECT 382 VLSI CIRCUITS**

Time: 3 Hrs Max.
Marks: 100

PART A
(***Answer All Questions***)

1	Which are the universal gates and why are they called as universal gates?	(3)
2	Draw the circuit diagram to realize a modulo 15 down counter	(3)
3	Draw VI characteristics of n- channel MOSFET and clearly mark different regions	(3)
4	Define lambda rules and micron rules.	(3)
5	List out the merits and drawbacks of np domino over domino logic	(3)
6	Explain the working of one transistor Dynamic Memory Cell.	(3)
7	Explain Moore slaw in VLSI design	(3)
8	Differentiate between full custom and semicustom design methods in ASIC design.	(3)
9	List different types of I/O cells used in programmable ASICs.	(3)
10	What is mean by critical path in an ASIC?	(3)

PART B
(***Answer one question from each module. Each question carries 14 mark.***)

11 (a)	With circuit and truth table, explain the working of a full adder. Also draw the schematic of 4 bit binary adder using full adder blocks	(8)
(b)	Construct a circuit to convert four bit serial data to parallel data and explain its working.	(6)
	OR	
12 (a)	Realize a 16:1 multiplexer using four bit multiplexers and basic gates. Also explain it using its switching expression	(8)
(b)	Explain the working of JK flip flop with its circuit and truth table	(6)
13 (a)	Draw VI characteristics of n-channel MOSFET and explain it with the current equation	(8)

	(b)	Draw the circuit diagram of a two input CMOS NAND gate	(6)

OR

14	(a)	Draw the stick diagram and Layout of a CMOS inverter	(8)
	(b)	Explain any 5 Lambda based design rules	(6)
15	(a)	Explain the Pre charge- Evaluate phase in the dynamic logic.	(6)
	(b)	Draw a 4x4 MOS ROM Cell Array and explain its working	(8)

OR

16	(a)	With neat schematic diagram, explain the working of NP domino logic. What is its advantage over domino logic?	(8)
	(b)	Explain the working of a three transistor DRAM cell	(6)
17	(a)	What is FPGA? What are its applications? With block diagram explain its internal architecture?	(7)
	(b)	Explain ASIC design flow.	(7)

OR

18	(a)	Explain the Top-Down and Bottom-Up design approaches in FPGA based system designs	(8)
	(b)	List the advantages of SOC	(6)
19	(a)	Explain the gate array based ASICs with neat diagram	(7)
	(b)	With necessary diagram illustrate antifuse technique used in programmable ASICs	(7)

OR

20	(a)	Discuss the different types of I/O cells that are used in programmable ASICS and their functions	(6)
	(b)	Define setup time, hold time, propagation delay and clock to output delay	(8)

ECT383	COMMUNICATION SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: The objective of this course to get awareness about various communication systems using in practice.

Prerequisite: NIL

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

CO1	Explain the components required for an Optical Communication Systems
CO2	Discuss the principle involved in RADAR and Navigation
CO3	Explain the concept and subsystems for Cellular Communication networks
CO4	Outline the requirement for Satellite communication systems
CO5	Discuss the role of different layers in TCP/IP protocol stack in communication networks

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Test		End Semester Examination
	1	2	
Remember, K1	10	10	10
Understand, K2	20	20	40
Apply, K3	20	20	50
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): Explain the components required for an Optical Communication Systems

1. Explain the block diagram for Optical Communication Systems
2. Distinguish between step index and graded index fiber
3. Explain various attenuations occurring in optical fiber

Course Outcome 2 (CO2): Discuss the principle involved in RADAR and Navigation

1. Explain Radar range equation and how the range of a radar system is increased?
2. Explain the block diagram for pulsed radar system
3. Explain Instrument landing system

Course Outcome 3 (CO3): Explain the concept and subsystems for Cellular Communication networks

1. What is frequency reuse?
2. Explain the principle of multicarrier communication
3. Explain GSM architecture

Course Outcome 4 (CO4): Outline the requirement for Satellite communication systems

1. Explain the block diagram for satellite uplink
2. What are geostationary satellites?
3. Explain various satellite orbits

Course Outcome 5 (CO5): Discuss the issues, challenges and architecture for various wireless ad hoc networks

1. Explain the issues and challenges of Wireless Ad Hoc Networks
2. What is 6LoWPAN?
3. Explain the function of each layer of TCP/IP protocol stack

Syllabus

Module 1 (Optical Communication)

Optical Communication System – Block Diagram – Advantages Of Optical Fiber Communication Systems – Principles Of Light Transmission In A Fiber Using Ray Theory – Single Mode Fibers, Multimode Fibers – Step Index Fibers, Graded Index Fibers (Basic Concepts Only) – Attenuation In Optical Fibers – Absorption Losses, Scattering Losses, Bending Losses, Core And Cladding Losses. **Optical transmitters**: LED and semiconductor LASER, characteristics, transmitter design. **Optical receivers**: Common photo detectors. Receiver design

Module 2 (Radar and Navigation)

Basic Radar System– Applications – Radar Range Equation (Qualitative Treatment Only) – Factors Influencing Maximum Range – Basic Pulsed Radar System – Block Diagram – Display Methods- A - Scope, PPI Display - Instrument Landing System – Ground Controlled Approach System.

Module 3 (Cellular Communication)

Cellular Communication, Hand off, Frequency Reuse, Principles of Multicarrier communication, Multiple Access techniques, CDMA Systems: General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink, GSM standard and service aspects – GSM architecture, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards,4G, 5G

Module 4 (Satellite Communication)

Basic concept of satellite communication, Keppler's law, Satellite orbits, Geosynchronous satellites, Active and Passive satellite, Block diagram for Satellite uplink, Transponder and earth station receiver

Module 5 (Data Communication and Networks)

Study of OSI and TCP/IP protocol suit: The Model, Functions of each layer, TCP/IP Protocol Suites. Wireless Ad Hoc Networks: Issues and Challenges, Wireless Sensor Networks: Architecture, Data dissemination, Data gathering, MAC Protocols, Location discovery, Quality of a sensor network 6LoWPAN

Textbooks

1. Electronic communication system fundamentals Wayne Tomasi, Pearson Education.
2. Data Communication and Networking by Behrouz A. Forouzan (Fourth Edition), Tata McGraw Hill

References

1. Wireless communication principles and practice T S Rappaport, Pearson Education.
2. G. E. Keiser – Optical Fibre Communication – Mc Graw Hill Publication.
3. D. C. Agarwal – Satellite Communication – Khanna Publications

4. Jochen Schiller - Mobile Communications- Pearson Education
5. Siva ram Murthy, B S Manoj- Ad Hoc Wireless Networks – Printice Hall

Course Contents and Lecture Schedule

Sl No	Topic	No.of Lecture hours
1.1	**Module 1** Optical Communication System – Block Diagram – Advantages Of Optical Fiber Communication Systems – Principles Of Light Transmission In A Fiber Using Ray Theory – Single Mode Fibers, Multimode Fibers – Step Index Fibers, Graded Index Fibers (Basic Concepts Only) – Attenuation In Optical Fibers – Absorption Losses, Scattering Losses, Bending Losses, Core And Cladding Losses.	4
1.2	**Optical transmitters**: LED and semiconductor LASER, characteristics, transmitter design. **Optical receivers**: Common photo detectors. Receiver design	4
2.1	**Module 2** Basic Radar System– Applications – Radar Range Equation (Qualitative Treatment Only) – Factors Influencing Maximum Range – Basic Pulsed Radar System – Block Diagram – Display Methods- A - Scope, PPI Display	4
2.2	Instrument Landing System – Ground Controlled Approach System.	3
3.1	**Module 3** Cellular Communication, Hand off, Frequency Reuse, Principles of Multicarrier communication, Multiple Access techniques, CDMA Systems: General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink	5
3.2	GSM standard and service aspects – GSM architecture, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards,4G, 5G	5
4.1	**Module 4** Basic concept of satellite communication, Keppler's law, Satellite orbits, Geosynchronous satellites	3
4.2	Active and Passive satellite, Block diagram for Satellite uplink, Transponder and earth station receiver	4
5.1	**Module 5** Study of OSI and TCP/IP protocol suit: The Model, Functions of each layer, TCP/IP Protocol Suites.	4
5.2	Issues and challenges in Wireless Ad Hoc Networks, Vehicular Ad Hoc Networks	2
5.3	Wireless Sensor Networks: Architecture, Data dissemination, Data gathering, MAC Protocols, Location discovery, Quality of a sensor network, 6LoWPAN	5

Sample Assignments

1. Explain the block diagram for optical communication systems
2. Write Radar range equation
3. Distinguish between A scope display and PPP display
4. Distinguish between step index and graded index fiber
5. Write Kepler's law for planetary motion

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH. DEGREE EXAMINATION

ECT 383: Communication Systems

Max. Marks: 100 Duration: 3hours

PART A

(Answer all questions. Each question carries 3 marks each.)

1. Compare the advantages and disadvantages of fiber-optic cables and metallic cables
2. Define Numerical Aperture
3. Write the RADAR range equation
4. Explain the principle of A-scope display
5. Why a honeycomb pattern was is selected for cell area?
6. Distinguish between soft handoff and hard handoff
7. Define Apogee and Perigee
8. Define look angles, angle of elevation and azimuth
9. List the challenges of wireless ad hoc networks
10. Explain 3-way handshaking

PART B

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

Module 1

11. (a) Explain different losses in Optical Fiber cable
    (b) Explain the operation of LED
12. (a)Explain the block diagram for Optical Fiber Communication
    (b) Explain the function of photodiode

Module 2

13. Explain the block diagram for pulsed RADAR
14. Explain the principle of PPI display

Module 3

15. Explain the architecture for GSM
16. Explain block diagram for CDMA system

Module 4

17. Explain Kepler's law of planetary motion
18. Explain the block diagram for satellite transponder

Module 5

19. Explain the role of each layer in TCP/IP protocol stack
20. Explain various data dissemination protocols used in wireless sensor networks

ECT384	DATA NETWORKS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to provide an insight into the concepts of data communication and networking.

Prerequisite: Nil

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

CO1 K2	Explain the concepts of data communication, structure of networks and compare OSI and TCP/IP networking models
CO2 K2	Explain the responsibilities of the data link layer including framing, addressing, flow control, error control and media access control
CO3 K2	Illustrate the functions and protocols of network layer, transport layer and application layer in inter-networking
CO4 K2	Discuss congestion control techniques and Quality of Service requirements for a network

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	20	15	20
Understand	K2	30	35	80
Apply				
Analyse				
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the concepts of data communication, structure of networks and networking models (K2)

1. Describe the various methods of data representation
2. Describe the different topologies of networks
3. Illustrate the functions of each layer in the OSI model

Course Outcome 2 (CO2): Explain the responsibilities of the data link layer including framing, addressing, flow control, error control and media access control (K2)

1. Describe the data link control
2. Explain the controlled access methods
3. Discuss the Pure ALOHA and Slotted ALOHA multiple access methods

Course Outcome 3 (CO3): Illustrate the functions and protocols of network layer, transport layer and application layer in inter-networking (K2)

1. Describe how logical addresses are mapped to physical address using RARP
2. Explain the application layer protocols
3. Explain the distance vector routing protocol

Course Outcome 4 (CO4): Discuss congestion control techniques and Quality of Service requirements for a network(K2)

1. Explain FIFO queuing and Priority queuing
2. Describe the characteristics attributed to a flow
3. Describe the operation of UDP

SYLLABUS

Module 1: An Overview of Data Communications and Networking

Data Communications- Components, Data representation, Data flow- Simplex, Half Duplex, Full Duplex Modes, Networks- Network criteria, Physical Structures- Point to Point Connection, Multipoint Connection, Physical Topology, Switching- Circuit Switched Networks and Datagram Networks, Categories of Networks, Interconnection of Networks, Protocols, Network models – OSI Model, Layers in the OSI Model, TCP/IP Protocol Suite

Module 2: Physical Layer and Data Link Layer

Guided Media and Unguided Transmission Media, Data Link Layer – Framing, Flow and Error Control - Stop and Wait Protocol, Sliding Window Protocol, Error Correction and Detection - Types of Errors, Redundancy, Detection vs Correction, Forward Error Correction vs Retransmission, Check Sum, Networking Devices- Hubs, Bridges, Switches

Module 3: Multiple Access, Ethernet, Wireless LANs

Multiple Access Protocols – Random Access, ALOHA, CSMA, CSMA/CD, CSMA/CA, Controlled Access, Channelization -FDMA, TDMA, CDMA, Ethernet -IEEE standards, Wireless LANs- IEEE 802.11, Bluetooth.

Module 4: Network Layer

Internetworking- Need for Network Layer, Internet as a Datagram Network, Internet as a Connectionless Network, Network Layer Logical Addressing – IPv4 and IPv6 Addressing only, Address Mapping -ARP, RARP, BOOTP, DHCP. Delivery, Forwarding, Routing Protocols - Distance Vector routing.

Module 5: Transport Layer, Congestion Control and Quality of Service

Transport layer – UDP, TCP, Congestion, Congestion Control, Quality of Service, Techniques to Improve QoS. Application Layer- FTP, Telnet, DNS, Electronic Mail

Text Book

Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill

Reference Books

1. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).
2. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004
3. Fred Halsall, Computer Networking and the Internet, 5/e, Pearson Education
4. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann

5. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e, Pearson Education

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**An Overview of Data Communications and Networking (9 hours)**	
1.1	Components, Data representation, Data flow -Simplex, Half Duplex, Full Duplex modes	1
1.2	Networks- Network criteria, Physical Structures- Point to Point Connection, Multipoint Connection	1
1.3	Switching- Circuit Switched Networks and Datagram Networks,	2
1.4	Categories of networks, Interconnection of networks, Protocols,	1
1.5	Network models – OSI Model, Layers in the OSI model,	3
1.6	TCP/IP Protocol Suite	1
2	**Physical Layer and Data Link Layer(9 hours)**	
2.1	Guided Media and Unguided Transmission Media	1
2.2	Data Link Control- Framing, Flow and Error Control- Stop and Wait Protocol, Sliding Window Protocol	2
2.3	Error Detection and Correction – Types of Errors, Redundancy, Detection vs Correction, Forward Error Correction vs Retransmission	2
2.4	Check Sum	2
2.5	Networking devices -Hubs, Bridges, Switches	2
3	**Multiple Access, Ethernet, Wireless LANs (8 hours)**	
3.1	Random Access, ALOHA, CSMA, CSMA/CD, CSMA/CA	2
3.2	Controlled Access	1
3.3	Channelization -FDMA, TDMA, CDMA	2
3.4	Ethernet -IEEE standards, Wireless LANs- IEEE 802.11, Bluetooth	3
4	**Network Layer (9 hours)**	
4.1	Internetworking- Need for Network Layer, Internet as a Datagram Network, Internet as a Connectionless Network,	1
4.2	Network Layer Logical Addressing -IPv4 and IPv6 Addressing only	2
4.3	Address Mapping -ARP, RARP, BOOTP, DHCP	2
4.4	Delivery, Forwarding	2
4.5	Routing - Distance Vector routing.	2
5	**Transport Layer, Congestion Control and Quality of Service (10 hours)**	
5.1	UDP, TCP	3
5.2	Congestion, Congestion Control	3
5.3	Quality of Service, Techniques to Improve QoS	2
5.4	Application Layer -FTP, Telnet, DNS, Electronic Mail	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT384

Course Name: DATA NETWORKS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Explain the flow of data between 2 devices	CO1,K2
2	Illustrate the factors that determine whether a system is a LAN or a WAN	CO1, K2
3	Explain character-oriented protocols	CO2, K2
4	Explain how guided media differs from unguided media	CO2, K2
5	Compare random access protocol and controlled access protocol	CO2, K2
6	Differentiate between BSS and ESS	CO2, K2
7	Describe the steps in ARP process	CO2, K2
8	Differentiate between a static and dynamic routing table	CO3, K2
9	Describe the characteristics attributed to a flow	CO4, K2
10	Describe how congestion control is achieved using choke packet	CO4, K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

11	Explain the responsibilities of the layers of OSI model.	CO1, K2

OR

12	(a) Illustrate the functioning of circuit switched networks and datagram networks	CO2, K2

Module - II

13.	Explain how bandwidth spreading is achieved using FSSS and DSSS.	CO2, K2

OR

14	Illustrate the Stop and Wait Protocol.	CO3, K2

Module - III

15	Explain the channelization protocols.	CO2, K2
	OR	
16	(a)Describe the Bluetooth layers (7 marks)	CO2, K2
	(b) Discuss the Hidden station problem and the exposed station problem in IEEE802.11 (7 marks)	CO2, K2

Module - IV

17	Describe mapping of logical addresses to physical addresses using ARP Protocol	CO3, K2
	OR	
18	Describe the routing of packets using the distance vector routing protocol (10 marks)	CO3, K2
	(b) Illustrate the functionality of the network layer at the source (4 marks)	CO3, K2

Module - V

19	Describe the ports, user datagram, checksum and operation of UDP protocol	CO4, K2
	OR	
20	(a) Explain the different techniques to improve the Quality of Service (10 marks)	CO4, K2
	(b) Describe the services of user agent in electronic mail systems (4 marks)	CO3, K2

ECT385	TOPICS IN DIGITAL IMAGE PROCESSING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to develop the skills for methods of various transformation and analysis of image enhancement, image reconstruction, image compression, image segmentation and image representation.

Prerequisite: ECT286 Introduction to Digital Signal Processing

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

CO 1	Analyze the various concepts and restoration techniques for image processing
CO 2	Differentiate and interpret the various image enhancement techniques
CO 3	Illustrate image segmentation algorithm
CO 4	Analyse basic image compression techniques

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse	K4			
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): Analyze the various concepts and restoration techniques for image processing

1. For the given image check whether pixel P and Q have 8 connectivity .
2. Find filtered image using median filter.
3. Explain Weiner filtering.

Course Outcome 2 (CO2): Differentiate and interpret the various image enhancement techniques

1. Classify different image enhancement process. Differentiate between spatial domain and frequency domain techniques of image enhancement.
2. What is histogram equalisation? Briefly discuss the underlying logic behind histogram equalisation.
3. Apply mean and median filters over a given image.

Course Outcome 3 (CO3): Illustrate image segmentation algorithm

1. Name two basic approaches of image segmentation and mention their differences.
2. How can you decide optimal thresholds when the image contains a background and several foreground objects? Write down a corresponding algorithm.
3. Write down the region growing algorithm. What are its advantages and disadvantages.

Course Outcome 4 (CO4): Analyze basic image compression techniques

1. What do you mean by compression ratio? Do you consider that lower compression ratio ensures better images upon reproduction?
2. How can achievable compression ratio to be determined from image histogram?
3. Mention the steps of lossy and lossless JPEG compression

SYLLABUS

Module 1

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

Brightness, contrast, hue, saturation, mach band effect, Colour image fundamentals-RGB, CMY, HIS models, 2D sampling, quantization.

Module 2

Image Enhancement: Spatial domain methods: point processing-intensity transformations, histogram processing, image subtraction, image averaging, geometric transformation
Sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Module 3

Image segmentation: Classification of Image segmentation techniques, region approach, clustering techniques
Classification of edges, edge detection, Hough transform, active contour
Thresholding – global and adaptive

Module 4

Image restoration: Restoration Models, Linear Filtering Techniques: Inverse and Wiener, Non linear filtering: Mean, Median, Max and Min filters
Noise Models: Gaussian, Uniform, Additive, Impulse
Image restoration applications

Module 5

Image Compression- Need for compression, redundancy, classification of image compression schemes, Huffman coding, arithmetic coding
Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding – DST, DCT, wavelet transform (basics only); Still image compression standards – JPEG and JPEG-2000

Text Books

1. Farid Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing ,Tata Mc Graw Hill, 2015

Reference Books

1. Jain Anil K, Fundamentals of digital image processing, PHI 1988
2. Kenneth R Castleman, Digital image processing, Pearson Education, 2/e, 2003
3. Pratt William K, Digital Image Processing, John Wiley,4/e, 2007.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition	1
1.2	Image sampling and quantization, basic relationships between pixels – neighbourhood, adjacency, connectivity, distance measures	2
1.3	Brightness, contrast, hue, saturation, mach band effect	3
1.4	Impulse response and its relation with transfer function of linear systems. Block diagram representation and reduction methods	3
1.5	2D sampling, quantization	1
2	**Image Enhancement**	
2.1	Spatial domain methods: point processing-intensity transformations	1
2.2	Histogram processing, image subtraction, image averaging, geometric transformations	3
2.3	Sharpening filters	2
2.4	First and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass	1
3	**Image segmentation:**	
3.1	Spatial domain methods: point processing-intensity transformations	3
3.2	Classification of Image segmentation techniques, region approach, clustering techniques	2
3.3	Classification of edges, edge detection, Hough transform, active contour	2
3.4	Thresholding – global and adaptive	3
4	**Image Restoration:**	
4.1	Restoration Models -Noise Models : Gaussian , Uniform, Additive, Impulse and Erlang	2
4.2	Linear Filtering Techniques : Inverse and Wiener	3
4.3	Non linear filtering: Mean, Median, Max and Min filters	2
4.3	Applications of Image restoration	1
5	**Image Compression-**	
5.1	Need for compression, redundancy,	1

5.2	classification of image compression schemes, Huffman coding, arithmetic coding	2
5.3	Redundancy–inter-pixel and psycho-visual;	1
5.4	Lossless compression – predictive, entropy;	2
5.5	Lossy compression- predictive and transform coding DST, wavelet	2
5.6	Still image compression standards – JPEG and JPEG-2000	1

Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/LabVIEW

1 Simple Image Processing Operations

- Read a gray scale image like *Lena* or *ascent*, available in the platform.
- Print the pixel values in $[0, 255]$ and appreciate them.
- Show the image.
- Observe the histogram of this image and appreciate it.
- Apply a nonlinear transformation such as logarithm of pixels and observe the changes in intensity due to compression/expansion of pixel values.
- Plot the histogram of the transformed image over the previous histgram and appreciate the changes.
- Apply cropping to the image and observe the cropped values.
- transform the gray scale image to a binary image by setting all values above 127 to 255 and those below to 0 and observe the binary image.
- Read in a color image and separate the RGB channels and observe them in color separately.
- Apply the logarithmic transfomation to all channels separately and combined the transformed images to form a new color image and com-pare with the original color image.

2 Image Compression with Singular Value De-composition

- Read in a gray scale and read the pixel values (I) into an array.
- Apply singular value decomposition of this array as

$$\tilde{I} = \sum_{i=0}^{Q} \lambda_i U_i V_i^T$$

- Plot the eiegn values and appreciate their fading in magnitude.
- Take the first $Q = 10$ eigen values and make the rest zero.
- Now reconstruct a compressed image for $Q = 10$, $Q = 100$ and appreciate the compression ratios.
- Take a picture of your face and crop it ito suitable dimensions and apply the previous steps and observe the compression by SVD.

3 Filters for Noise Removal

- Read in a gray scale image and observe it.
- Add AWGN to it of known variance.
- Construct mean and median filters and apply on the noisy images and observe the removal of noise.
- Quantify the noise removal by computing the SNR and PSNR values as

$$SNR = 10\log_{10}\left[\frac{\sum_{n_1}\sum_{n_2} r^2[n_1,n_2]}{\sum_{n_1}\sum_{n_2}[r^2[n_1,n_2]-t^2[n_1,n_2]]}\right]$$

  The peak value of the SNR is expressed as

$$PSNR = 10\log_{10}\left[\frac{\max\left(r^2[n_1,n_2]\right)}{\frac{1}{N_1N_2}\sum_{n_1}\sum_{n_2}[r^2[n_1,n_2]-t^2[n_1,n_2]]}\right]$$

  where r denotes the reference image and t denotes the test image.

- Plot these values against different noise variances for mean and median filters and appreciate.

4 Gaussian Filter for Smoothing

- Read in a gray scale image and observe it.
- Realize a Gaussian kernel with impulse response

$$h = \frac{1}{273}\begin{bmatrix} 1 & 4 & 7 & 4 & 1 \\ 4 & 16 & 26 & 16 & 4 \\ 7 & 26 & 41 & 26 & 7 \\ 4 & 16 & 26 & 16 & 4 \\ 1 & 4 & 7 & 4 & 1 \end{bmatrix}$$

- Perfom the two dimensional convolution and observe the smoothinng, Also observe the blurring.
- Make the image noisy and repeat the procedure.
- Assess the visual quality of the image after Gaussian smoothing by computing teh structural similarity index as

$$SSIM(\mathbf{x},\mathbf{y}) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(2\mu_x^2 + 2\mu_y^2 + C_1)(2\sigma_x^2 + 2\sigma_y^2 + C_2)}$$

  The parameters μ_x and μ_y are the means and σ_x^2 and σ_y^2 are the variances of $\mathbf{x}$ and $\mathbf{y}$ respectively. σ_{xy}^2 is the covariance between $\mathbf{x}$ and $\mathbf{y}$. C_1 and C_2 are non-zero constants included to avoid unstable results when $\sigma_x^2 + \sigma_y^2$ or $\mu_x^2 + \mu_y^2$ is very close to zero.

- One may take $\mathbf{x}$ as the input image and $\mathbf{y}$ as the filtered image and appreciate the performance of the filter.

5 Edge Detection Filters

- Read in a grayscale image.
- Construct a Laplacian filter with kernel

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

- Apply Laplacian filter to the image and observe the edges.

- Test the invulnerability of edge detection to noise. Add noise to the signal of known variance and extract edges.
- Compute the cripness of the edges (κ) with

$$\kappa = \frac{1}{N_1 N_2} \sum_{n_1} \sum_{n_2} \frac{|\sigma^2_{l[n_1,n_2]_{test}} - \sigma^2_{l[n_1,n_2]_{ref}}|}{\sigma^2_{l[n_1,n_2]_{ref}} \mu_{l[n_1,n_2]_{ref}}}$$

  where the reference image is the output of filter without noise and the test image is the one with noise.
- Plot κ for different noise variances.
- Use the Gaussian kernel in Sec. 4 to perfom two dimnsion convolution an the image.
- Perform Laplacian filtering on the resultant image to perform Laplacian of Gaussian (LoG) filtering. Observe the edges detected.
- Compute κ for different noise variances and compare the plots with those of Laplacian and understand the noise invulnerability of LoG filter.

6 Image Compression with DCT

- Read in a gray scale image.
- Apply type-II DCT and observe the coefficient.
- Make DCT coefficients that are less than 20% of the maximum equal to zero.
- Take inverse DCT and observe the image. Compute the compression ratio.
- Repeat for 30%, 40% and 50% values and observe the compressed image and the compression ratios.

ECT386	TOPICS IN COMPUTER VISION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to develop the knowledge of various methods, algorithms and applications of computer vision

Prerequisite: **Nil**

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

CO1	Apply basic point operators and 2D transforms for digital filtering operations
CO 2	Apply various algorithms for morphological operations and binary shape analysis.
CO3	Understand the theoretical aspects of image formation and 3D camera models and vision system.
CO 4	Apply edge, corner detection methods and optical flow algorithms to locate objects in an image/video.
CO5	Analyse 3D images and motion of objects in a given scene using appropriate algorithms computer vision algorithms for real time practical applications.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	10	10	20
Apply	K3	20	20	70
Analyse	K4	10	10	
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): Apply basic point operators and 2D transforms for digital filtering operations

1. Why histogram transformations are applied in a grey scale image and what output is observed in that case.
2. Find filtered image using LP/HP/Smoothing/Median filter.
3. Describe the working principle of Homomorphic filter.

Course Outcome 2 (CO2): Apply various algorithms for morphological operations and binary shape analysis

1. List different morphological operators and describe about each one in detail.
2. To describe connected component labelling and to apply it in a given image pixel set.
3. Find 8-point connectivity and Chain code of a given image pixel diagram.

Course Outcome 3 (CO3): Understand the theoretical aspects of image formation and 3D camera models and vision system.

1. Differentiate between Monocular and binocular imaging system.
2. Compare and Contrast Orthographic and Perspective Projection methods.
3. Describe image formation and geometric transformations in 3D Camera Models.
4. Write short notes on 3D-Imaging system.
5. Briefly describe a stereo vision system.

Course Outcome 4 (CO4): Apply edge, corner detection methods and optical flow algorithms to locate objects in an image/video.

1. What is the role of edge detection and corner detection in Computer Vision applications?
2. Describe Canny's edge detection algorithm.
3. Mention the steps in Harris corner detection algorithm and explain how it is employed to detect corners in an image.
4. State with necessary mathematical steps, how Hough transform is employed for detecting lines and curves in detecting an image.

Course Outcome 5 (CO5): Analyse 3D images and motion of objects in a given scene using appropriate computer vision algorithms for real time practical applications.

1. Find Eigen values and Eigen Vectors of the following matrix

$$A=\begin{bmatrix} 8 & -8 & -2 \\ 4 & -3 & -2 \\ 3 & -4 & 1 \end{bmatrix}$$

2. Analyse a given video to track a moving object in it.
3. To detect a particular object from the background.
4. To detect signboards/ pedestrian crossings/pedestrians from a moving vehicle.
5. To classify/segment a particular set of image using CV algorithms.
6. Analyse a given image/video using Machine learning/Deep learning algorithms.
7. Use trained networks to analyse a video using ML algorithms.
8. To use Deep neural networks/CNN/YOLOvx, to analyse images/videos

SYLLABUS

Module 1

Review of image processing techniques: Filtering, Point operators-Histogram Based operators, neighbourhood operators, Thresholding - linear filtering – development of filtering masks - 2D Fourier transforms – filtering in frequency domain, Homomorphic filtering

Module 2

Mathematical Operators: Binary shape analysis: Basics of Morphological operations, structuring element, Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform, Connectedness, object labelling and counting , Boundary descriptors – Chain codes.

Module 3

Camera models: Monocular and binocular imaging system, Orthographic and Perspective Projection, Image formation, geometric transformations, Camera Models (Basic idea only), 3D-Imaging system-Stereo Vision.

Module 4

Feature Detection: Edge detection – edges, lines, active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts, energy-based and Canny's methods.
Corner detection, Harris corner detection algorithm, Line and curve detection, Hough transform
SIFT operators, Shape from X, Shape Matching, Structure from motion.

Module 5

Motion Analysis- Regularization theory, Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method. (Analysis not required) Object Detection and Object classification: SVM, Linear discriminant analysis, Bayes rule, ML.

Face detection, Face Recognition, Eigen faces, 3D face models

Applications of Computer Vision: Context and scene understanding, Real Time applications: Locating road way and road marking, locating road signs and pedestrians.

Text Books

1. E. R .Davies, Computer and Machine Vision -Theory Algorithm and Practicalities, Academic Press, 2012
2. Richard Szeliski, Computer Vision: Algorithms and Applications, ISBN 978-1-84882-935-0, Springer 2011.
3. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson India, 2002.

Reference Books

1. Goodfellow, Bengio, and Courville, Deep Learning, MIT Press, 2006.
2. Daniel Lelis Baggio, Khvedchenia Ievgen, Shervin Emam, David Millan Escriva, Naureen Mahmoo, Jason Saragi, Roy Shilkrot, Mastering Open CV with Practical Computer Vision Projects, Packt Publishing Limited, 2012
3. Simon J D Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
4. R. J. Schalkoff, Digital Image Processing and Computer Vision, John Wiley, 2004.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Review of image processing techniques: filtering.	2
1.2	Point operators- Histogram, neighbourhood operators, thresholding–development of filtering masks	3
1.3	2D Fourier transforms – filtering in frequency domain, homomorphic filtering	3
2	**Mathematical Operators:**	
2.1	Basics of Morphological operations , structuring element	2
2.2	Binary shape analysis : Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform	2
2.3	Connectedness, object labelling and counting	2
2.4	Boundary descriptors –Chain Codes.	2
3	**Camera models**	
3.1	Monocular and binocular imaging system	2
3.2	Orthographic & Perspective Projection	2
3.3	Image formation, geometric transformations, camera Models(Basic idea only)	3
3.4	3D-Imaging system-Stereo Vision	2
4	**Feature Detection:**	
4.1	Edge detection – edges, lines, active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts, energy-based	4

	and Canny's methods.	
4.2	Corner detection, Harris corner detection algorithm, Line and curve detection, Hough transform	3
4.3	SIFT operators, Shape from X, Shape Matching	3
5	**Motion Analysis**	
5.1	Motion Analysis- Regularization theory, Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method (Analysis not required)	3
5.2	Object Detection and Object classification: SVM, Linear discriminant analysis, Bayes rule, maximum likelihood, Face detection, Face Recognition, Eigen faces, 3D face models	4
5.3	Applications of Computer Vision: Context and scene understanding, Real Time applications: Locating road way and road marking, locating road signs and pedestrians	3

Simulation Assignments

The following simulations can be done in OpenCV/SciLab/ MatLab

1. Design and implementation of basic digital filters.
2. Apply thresholding operations in a digital image.
3. Apply point operators in an image – averaging/smoothing, 2D - masks(3 types),
4. Apply morphological operations in a selected image like fingerprint/ archaeological scripts.
5. Implement filters in 2D-frequency domain using Gaussian/Homomorphic filters in a particular satellite image or forensic image.
6. Write algorithms for connected component labelling in a given image pixel set.
7. Detect a coin/ball against the background using background subtraction and with appropriate edge detection algorithms.
8. Locate corners of a particular image like boxes/ building/TV screen etc
9. Write a program to implement brightness constancy equation.
10. Analyse the optical flow of a given video using Horn-Schunk method or/and Lucas-Kannade method/s.
11. Use PCA for dimensionality reduction in detecting faces using Eigen values.
12. Implement SVM/LDA for a practical application.
13. Create an attendance system by implementing face recognition method, among a set of students.
14. With OpenCV library, implement real time scene analysis for traffic regulation. (cases such as detecting road signs/ pedestrians/track a particular vehicle/ detect traffic lights/detect number plate of a vehicle/ detect accidents/ accident scene analysis etc., etc.).
15. Use ML/DL algorithms to implement object detection/identification/classification, with trained neural networks for applications in medical/agricultural/sports fields.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: EC386

Course Name: TOPICS IN COMPUTER VISION

(Minor)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each carries 3 marks.

1	Compare and Contrast DoG and LoG.	K1
2	An image is convolved with the matrix given below. Express analytically the relation between original and modified image.	K2

•0	•0	•0
•0	•0	•1
•0	•0	•0

3	List any three computer vision applications of object labeling and counting.	K2
4	Describe steps in identifying connected components in 4-connectivity and 8-connectivity cases.	K2
5	Describe the working principle of pin- hole camera	K2
6	Compare and contrast perspective and orthographic projection.	K2
7	Mention the concept of identifying structure from motion.	K2
8	Illustrate how graph cut method is employed for edge detection	K2
9	Define eigen values and eigen vectors.	K2
10	Differentiate between SVM and LDA.	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	
11 a	What is thresholding? Briefly describe different methods of thresholding.	(6) CO1 K1

<table>
<tr><td>11 b.</td><td>Apply 2D-DFT on the given image pixel values

$$\begin{bmatrix} 1 & 2 & 2 & 0 \\ 0 & 1 & 3 & 1 \\ 0 & 1 & 2 & 1 \\ 1 & 2 & 2 & -1 \end{bmatrix},$$</td><td>(8)
CO1
K3</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>12 a</td><td>Describe how histogram transformations are applied on a grey scale image and explain what output is observed in each case.</td><td>(8)
CO1
K3</td></tr>
<tr><td>12 b.</td><td>Describe the working principle of Homomorphic filter, with different mathematical steps involved.</td><td>(6)
CO1
K2</td></tr>
<tr><td></td><td>Module - II</td><td></td></tr>
<tr><td>13a</td><td>An image A, and a structuring element B are given. Apply B on A, to find resultant images after the dilation and erosion process. Origin is given as ‘O’; and note that it is not part of the structuring element.

A =
<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>1</td><td>1</td><td>1</td><td></td><td></td></tr>
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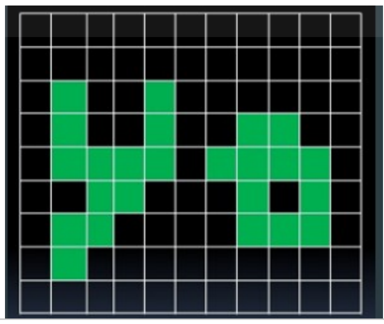
<tr><td></td><td></td><td></td><td></td><td>1</td><td>1</td></tr>
<tr><td>O</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

B =
<table>
<tr><td>1</td><td>O</td><td>1</td></tr>
</table></td><td>(8)
CO2
K3</td></tr>
<tr><td>13 b.</td><td>Using Hoshen–Kopelman algorithm, assign connected component labelling for the given image in the diagram below.
</td><td>(6)
CO2
K3</td></tr>
</table>

OR

14a Apply Hit-or-Miss transform on the given binary image to detect right angle convex corners from left-top to right-bottom. (8) CO2 K3

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0
0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	0	0	1	1	1	1	1	0	0	0
0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0
0	0	1	1	0	0	0	0	0	1	1	1	1	0	0	0
0	0	1	1	0	0	0	0	0	1	1	1	1	0	0	0
0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0
0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0
0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0
0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

14b. (6) CO2 K3

		x	x	x		
	x				x	
		x		x		
		x			x	
			x	x		

For the given image grid, find out the 8-chain Freeman Code. Also write down the chain number of the code.

15 Describe image formation and geometric transformations in 3D Camera Models. (14) CO3 K2

OR

16a Briefly describe a stereo vision system. (7) CO3 K2

16 b Elucidate on 3D-Imaging Camera system. (7) CO3 K2

<table>
<tr><td></td><td>Module - IV</td><td></td></tr>
<tr><td>17a</td><td>With the help of a general algorithm, narrate how Hough Transform can be employed for interest point detection.</td><td>(6)
CO4
K3</td></tr>
<tr><td>17 b</td><td>Unveil different steps involved in Harris corner detection algorithm and explain how it is employed to detect corners in an image

OR</td><td>(8)
CO4
K3</td></tr>
<tr><td>18 a.</td><td>Apply Sobel and Prewitt masks on the given image grids and compute Gx and Gy gradients of the images.
<table>
<tr><td>0</td><td>0</td><td>10</td><td>10</td><td>10</td></tr>
<tr><td>0</td><td>0</td><td>10</td><td>10</td><td>10</td></tr>
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<tr><td>0</td><td>0</td><td>10</td><td>10</td><td>10</td></tr>
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y, x
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<tr><td>10</td><td>10</td><td>10</td><td>10</td><td>10</td></tr>
</table>
y, x</td><td>(6)
CO4
K3</td></tr>
<tr><td>18 b.</td><td>Referring to Canny’s algorithm, describe how it is employed to detect edges of an image.</td><td>(8)
CO4
K3</td></tr>
<tr><td></td><td>Module - V</td><td></td></tr>
<tr><td>19 a</td><td>Derive brightness constancy equation.</td><td>(6)
CO5
K3</td></tr>
<tr><td>19 b</td><td>Describe with algorithmic steps, the Horn-Shunk method used for the estimation of optical flow.</td><td>(8)
CO5
K3</td></tr>
<tr><td>20 a</td><td>Illustrate the concept of dimensionality reduction using Principal Component Analysis (PCA) with all mathematical steps involved.</td><td>(7)
CO5
K3</td></tr>
<tr><td>20b.</td><td>With the help of a flow chart, illustrate an in-vehicle vision system, for locating roadways and pedestrians, as a practical application of computer vision.</td><td>(7)
CO5
K3</td></tr>
</table>

ECD481	MINIPROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course aims

- To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system
- For enabling the students to gain experience in organisation and implementation of small projects.
- Design and development of Small electronic project based on hardware or a combination of hardware and software for electronics systems.

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, this should be a working model. The basic concept of product design may be taken into consideration.

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

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

Course Outcomes

CO1	Be able to practice acquired knowledge within the selected area of technology for project development.
CO2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.
CO3	Reproduce, improve and refine technical aspects for engineering projects.
CO4	Work as a team in development of technical projects.
CO5	Communicate and report effectively project related activities and findings.

Mapping of course outcomes with program outcomes

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

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

ECD482	MINIPROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course aims

- To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system
- For enabling the students to gain experience in organisation and implementation of small projects.
- Design and development of Small electronic project based on hardware or a combination of hardware and software for electronics systems.

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, this should be a working model. The basic concept of product design may be taken into consideration.

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

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

Course Outcomes

CO1	Be able to practice acquired knowledge within the selected area of technology for project development.
CO2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.
CO3	Reproduce, improve and refine technical aspects for engineering projects.
CO4	Work as a team in development of technical projects.
CO5	Communicate and report effectively project related activities and findings.

Mapping of course outcomes with program outcomes

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

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