वियोज्य DETACHABLE

ELECTRONICS & TELECOMMUNICATION ENGINEERING

Paper II

Time Allowed : Three Hours	Maximum Marks : 300

QUESTION PAPER SPECIFIC INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

There are **EIGHT** questions divided in **TWO** Sections.

Candidate has to attempt **FIVE** questions in all.

Question Nos. **1** and **5** are **compulsory** and out of the remaining, any **THREE** are to be attempted choosing at least **ONE** question from each Section.

The number of marks carried by a question/part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Diagrams/figures, wherever required, shall be drawn in the space provided for answering the question itself.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

Answers must be written in **ENGLISH** only.

SECTION 'A'

1.(a) In a narrow band digital communication system the symbol error probability for the in-phase channel is P_{eI} and for quadrature phase channel is P_{eQ}. Prove that the probability of symbol error for the overall system is given by (P_e) :

$$P_e = P_{eI} + P_{eQ} - P_{eI}P_{eQ}$$ 10

1.(b) Consider a discrete time system with impulse response $h[n] = \left(\frac{1}{5}\right)^{2n} U[n]$. Find the value of constant A such that $h[n] - Ah[n-1] = \delta[n]$ and $\delta[n]$ is a unit impulse signal. 10

1.(c) A digital computer has a memory unit with 32 bits per word. The instruction set consists of 240 different operations. All instructions have an operation code part (opcode) and an address part (allowed for only one address). Each instruction is stored in one word of memory.

(i) How many bits are needed for the opcode ?

(ii) How many bits are left for the address part of the instruction ?

(iii) What is the maximum allowable size of the memory ? 10

1.(d) The Radiation intensity of an antenna is

$$U(\theta, \phi) = \begin{cases} 2\sin\theta\sin^2\phi & 0 \leq \theta \leq \pi,\ 0 \leq \phi \leq \pi \\ 0 & \text{elsewhere} \end{cases}$$

Determine the directivity of the antenna. 10

1.(e) A graded index fiber has a characteristics refractive index profile of 1·85 and a core diameter of 60 μm. Compute the insertion loss due to a 5 μm lateral offset at an index matched fiber joint assuming the uniform illumination of all guided modes. 10

1.(f) A mobile network transmits data having bandwidth of 200 Hz using a carrier frequency of 800 MHz. If the maximum speed of a vehicle is 120 km/hr, calculate the bandwidth and the cut-off frequencies of the filter at the receiver input. 10

2.(a) Two speech signals $m_1(t)$ and $m_2(t)$ are used to generate a composite signal as :

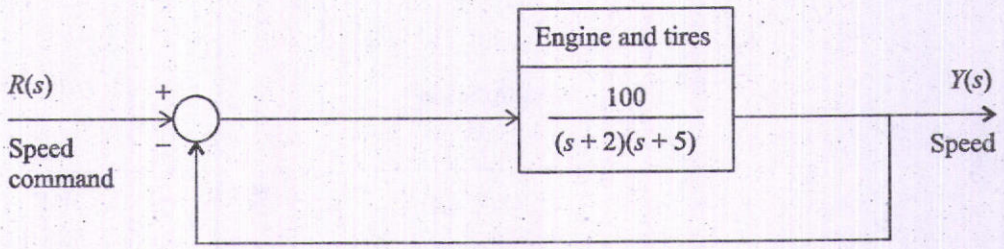
$$s(t) = m_1(t)\cos\omega_c t + m_2(t)\sin\omega_c t$$

Assume both the messages are low pass in nature and have W Hz bandwidth.

(i) Draw the block diagram and show the generation scheme of $s(t)$. 8

(ii) Propose a demodulation scheme in the form of block diagram and show the recovery of the two signals $m_1(t)$ and $m_2(t)$. Assume $\omega_c >> 2\pi W$. 12

2.(b) The engine, body, and tires of a racing vehicle affect the acceleration and speed attainable. The speed control of the car is represented by the model as shown in the following figure.



(i) Calculate the steady state error of the car to a step command in speed. 5

(ii) Calculate the overshoot of the speed to a step command. 15

2.(c) A digital computer has memory capacity of 32767 words with 48 bits per word. The instruction code format consists of 8 bits for the operation part and 16 bits for the address part. Two instructions are packed in one memory word and 48 bit instruction register IR is available in the control unit. Formulate the procedure for fetching and executing the instructions for this computer. 20

3.(a) A digital communication system uses five symbols $\{S_0, S_1, S_2, S_3, S_4\}$ with their following probabilities of occurrence

S_0	S_1	S_2	S_3
0·55	0·20	0·10	0·10

(i) Compute Huffman code for these symbols by moving the combined symbol as low as possible. 15

(ii) Calculate the average code word length. 5

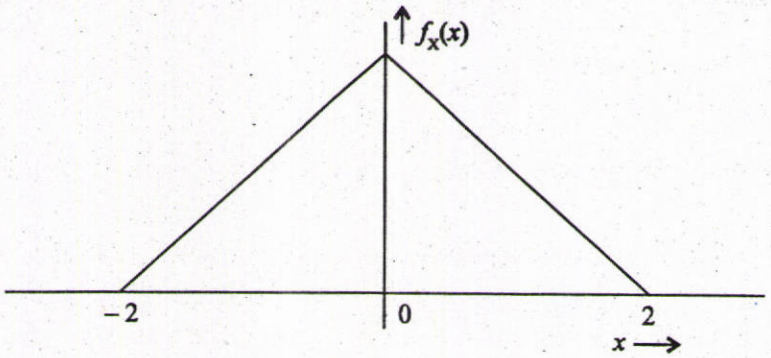
3.(b) A unity feedback control system has $KG(s) = \dfrac{K(s+2)}{s(s+1)}$

(i) Find the breakaway and entry points on the real axis. 10

(ii) Find the gain and the roots when the real part of the complex roots are located at –2. 10

3.(c) What is virtual memory ? How it is different from main memory ? Suppose CPU generates 32 bit virtual addresses and the page size is 16 KB. The processor has a translation look-aside buffer (TLB) which can hold a total of 512 page table entries and is 4-way associative. Calculate the size of TLB tag. 20

4.(a)



A low pass stationary process $X(t)$ has probability density function (at any given point of time) as shown in the figure. This process has a bandwidth of 5 kHz and is to be transmitted by using a PCM system.

(i) Calculate the signal to quantization noise ratio (in dBs) if the sampling is done at the Nyquist rate and 5 bit uniform quantizer is used. 8

(ii) Calculate the bit rate generated. 4

(iii) If the maximum bit rate supported by the channel is 64 kbps, calculate the possible improvement in signal to quantization noise ratio if the uniform quantizer is redesigned. 8

4.(b) A simple unity feedback control system has a process transfer function $G(s) = \frac{K}{s}$. The system input is a step function with an amplitude A. The initial condition of the system at time t_0 is $y(t_0) = Q$, where $y(t)$ is the output of the system. The performance index of the system is defined as $I = \int_0^\infty e^2(t)dt$ where $e(t)$ is the error in the system response. Show that performance index I is given as $\frac{(A-Q)^2}{2K}$ where K is gain. 20

4.(c) What are the advantages and disadvantages of recursion ? Write a code/pseudocode (in any standard programming language) with proper statements to accept a string as a command line argument and hence find its length. 20

SECTION 'B'

5.(a) In a system if data is transmitted to remote location using 8 bit PCM encoding, find

(i) Channel capacity if Bandwidth is 300 kHz and SNR = 15 dB. 4

(ii) the maximum number of channels that can be accommodated in this scheme if Time Division Multiplexing is used with each channel having 5 kHz fixed bandwidth allocation. 6

5.(b) A system is described by the state equations

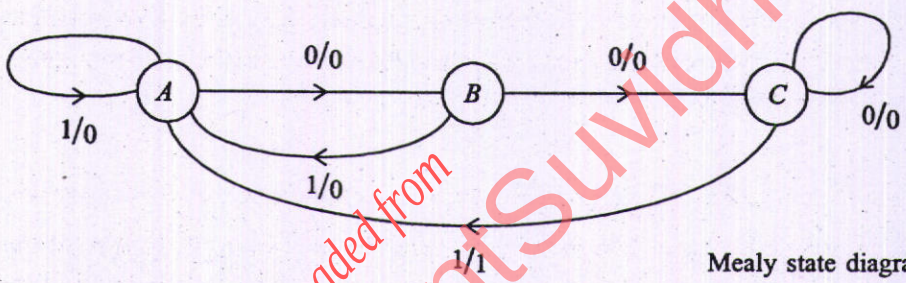
$$\dot{X} = \begin{bmatrix} 3 & 0 \\ -1 & 1 \end{bmatrix} X + \begin{bmatrix} -1 \\ 1 \end{bmatrix} U \text{ and } Y = [1 \quad 1] X.$$

Determine whether the system is controllable and observable. 10

5.(c) An analog cellular system has a total of 33 MHz of bandwidth and uses two 25 kHz simplex channels to provide full duplex voice and control channels. What is the number of channels available per cell for a frequency reuse factor of 4 cells ? If 1 MHz is dedicated to a control channel then how many voice channels will be available for reuse factor of 4 cells. 10

5.(d) Find the potential at a point P which is 1 m radial distance from the midpoint of a 2 m straight line charge of uniform density 10 nC/m in air. If this line charge is bent to form an arc of a circle of radius 1 m, find the percentage change in potential at the same point P. Give reason for this change. 10

5.(e)



Mealy state diagram

Construct the state diagram for a Moore circuit from the given Mealy circuit. 10

5.(f) A message consists of blocks of 8 bits. A checksum of 8 bits is added after every two blocks. If the first two blocks of a message are :

(i) Find the checksum bits transmitted. 5

(ii) If the channel error causes bits to reverse at the MSB place of both the blocks, find the recovered bit pattern after checksum. 5

6.(a) The relative permittivity of a dielectric material between the plates of parallel plate capacitor varies uniformly from $\in r_1 = 1$ at one plate to $\in r_2 = 4$ at other plate. The area of each plate is 1 m^2. Find the capacitance per unit length of this capacitor if $d = 3$ mm. Derive the equation used. 20

6.(b) (i) Discuss the priority of interrupts of 8086. Draw a circuit that will terminate the INTR when interrupt request has been acknowledged. 15

(ii) Explain Direct Memory Access (DMA) mode of data transfer. 5

6.(c) A network with 6 nodes with associated cost function is given in the Table below. Calculate the routing table using the shortest path Dijkstra's Algorithm assuming Node 1 as the source node. NC represents no connection between the nodes.

Node Number → ↓	1	2	3	4	5	6
1	–	3	2	5	NC	NC
2	3	–	NC	1	4	NC
3	2	NC	–	2	NC	1
4	5	1	2	–	3	NC
5	NC	4	NC	3	–	2
6	NC	NC	1	NC	2	–

20

7.(a) A lossless line with $L = 0{\cdot}5$ μH/m and $C = 150$ PF/m is operated at a frequency 10 MHz. Find the shortest length of line at which it acts as

(i) 150 PF Capacitor on an open circuit and short circuit.

(ii) 2 μH Inductor on an open circuit and short circuit. 20

7.(b) (i) Implement the following Boolean functions using PLA :

Sum $(A, B, C_{in}) = \Sigma m(1, 2, 4, 7)$

Cout $(A, B, C_{in}) = \Sigma m(3, 5, 6, 7)$ 10

(ii) Explain photolithography process. Also, explain the importance of photoresists. 10

7.(c) (i) Calculate the degradation in the downlink $\left(\frac{C}{I}\right)$ ratio when orbital spacing between the satellites is reduced from 5° to 2°, all the other factors remaining unchanged. Assume antenna characteristics as per Federal Communications Commission (FCC) norms. 10

(ii) A low noise amplifier is connected to a receiver which has a noise figure of 12 dB. The power gain of the low noise amplifier is 1000 and its noise temperature referred to the low noise amplifier input. 10

8.(a) The inside dimensions of 9 GHz air filled waveguide are 2·286 cm × 1·016 cm. Find the maximum power that can be transmitted in the TE mode assuming that the breakdown electric field intensity is 3×10^6 V/m. 20

8.(b) (i) For given discrete time systems, where $y[n]$ and $x[n]$ are the output and the input sequences, respectively. Determine, whether or not the system is — linear, causal, stable and time-invariant.

(A) $y[n] = n^2x[n]$ (B) $y[n] = x[n-5]$ 10

(ii) Develop two different cascade canonic realization of given causal IIR transfer function

$$H(z) = \frac{\left(0{\cdot}3 - 0{\cdot}5z^{-1}\right)\left(2 + 3{\cdot}1z^{-1}\right)}{\left(1 + 2{\cdot}1z^{-1} - 3z^{-2}\right)\left(1 + 0{\cdot}67z^{-1}\right)}$$ 10

8.(c) Describe the mechanism of intermodal dispersion in a multimode step index fiber. Show that the total broadening of a light pulse δT_s due to intermodal dispersion in a multimode step index fiber may be given as :

$$\delta T_s \approx \frac{L(NA)^2}{2n_1C}$$

where L is the fiber length, NA is the numerical aperture of the fiber, n_1 is the core refractive index and C is the velocity of light is a vacuum. 5+15