वियोज्य *DETACHABLE*

ELECTRONICS AND 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.

Questions No. **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.

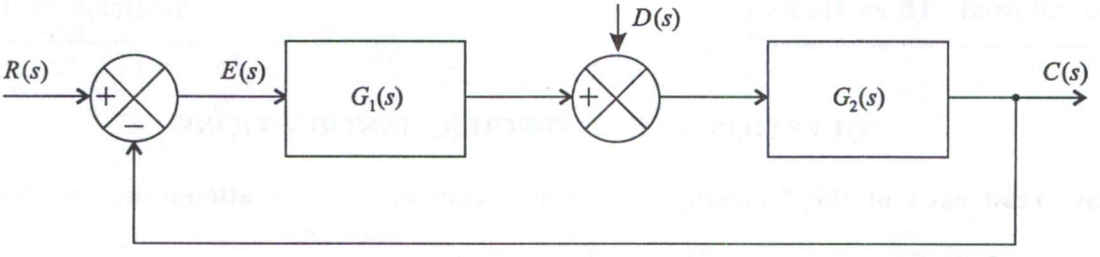
Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

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

SECTION 'A'

1.(a) A random process $Y(t)$ is obtained by multiplication of a stationary process $X(t)$ with a sinusoidal wave $\cos(2\pi f_c t + \theta)$ where the phase θ is a random variable that is uniformly distributed over the interval $[0, 2\pi]$.
Express the power spectral density of random process $Y(t)$ in terms of power spectral density of $X(t)$. Assume that random variable θ is independent of $X(t)$. 10

1.(b) Consider the system shown below :



Here $G_1(s) = \dfrac{100(s+5)}{s+2}$

$G_2(s) = \dfrac{5}{s(s+4)}$

Determine the steady state error due to unit step input and a step disturbance of 10 unit. 10

1.(c) Find out the time complexity of the following code segment :

```
for (i = n/2; i < n; i++)
    for (k = 1; k < i; k *= 2)
      count += n * n;
```
10

1.(d) Determine the divergence of the vector field $\vec{A}$ and evaluate them at the specified point :

$\vec{A} = \rho z \sin\phi \, \hat{a}_\rho + 3\rho z^2 \cos\phi \, \hat{a}_\phi$ at $(5, \pi/2, 1)$. 5+5=10

1.(e) Use Euler path method to find out optimal gate ordering for the stick diagram and layout of CMOS implementation of the Boolean expression $\overline{A(B+C)+DE}$. 10

1.(f) A bit stream 10011101 is received (LSB is received first). The transmitter is using standard CRC method with the generator polynomial $x^3 + 1$. Show the actual bit stream transmitted. Show that the error is detectable at the receiver's side. 5×2=10

2.(a) Consider that, two input signals of a Binary Phase Shift Keying (BPSK) receiver are $\pm \sin 2\pi f_c t$ (where 'f_c' is carrier frequency). Draw the functional block diagram of a BPSK receiver to recover the bit stream of '0' and '1'. Give the necessary mathematical interpretation of the signals. 20

2.(b) Show that the maximum phase lead of a lead compensator occurs at frequency $\sqrt{ab}$, where $(-a)$ and $(-b)$ are the locations of zero and pole respectively of the lead compensator. 20

2.(c) A system has 512 mega bytes of main memory and 128 kilo bytes of cache memory. Memory is word addressable with 32 bit word size. Cache memory is 8-way associative with 128 byte block size. Calculate the number of tag bits required for this set associative cache mapping scheme. 20

3.(a)(i) Amplitude Modulation (AM) transmitter with a carrier power of 900 W, transmits a power of 1·1 kW, when modulated with a single sine wave. Calculate the percentage of modulation.

If the same carrier is simultaneously modulated with one more sine wave of 50% modulation, calculate the total transmitted power. 4+6=10

3.(a)(ii) Frequency modulation (FM) broadcast system is having a maximum frequency deviation of 75 kHz and modulating frequency of 15 kHz. Calculate the modulation Index and the required bandwidth using Carson's rule. Discuss whether this FM broadcast system is narrowband or wideband. Justify your answer. 10

3.(b)(i) The forward path transfer function of a negative unity feedback system is given by $G(s) = \dfrac{K}{s(s+T)}$. Determine the values of K and T such that all the roots of characteristic equation are in the left-half plane of the vertical line passing through $s = -a$. 10

3.(b)(ii) A negative feedback control system has the forward path transfer function $G(s) = \dfrac{K(s+0{\cdot}5)}{s^2(s+12)}$ and feedback transfer function $H(s) = 1$. Find the value of K at the breakaway points. 10

3.(c) An embedded system for a plant control uses two processes $P1$ and $P2$. High priority process $P1$ reads temperatures from two sensors at regular interval t and updates the latest temperature values in two fixed memory locations $T1$ and $T2$ sequentially. Low priority process $P2$ uses the values stored in locations $T1$ and $T2$ to calculate the average of this set of values. If the average of any set of values happens to be more than 50, then $P2$ calls a function to sound an alarm. The loop time of $P2$ is variable, but is ensured to be always less than t.

(i) Write an indicative pseudocode describing the above situation and mention what can go wrong in this case.

(ii) Suggest appropriate operating system mechanism for solving the possible code problem with appropriate modifications in the pseudocode for part (i) above. 10+10

4.(a)(i) Plot the entropy function of a Binary Memoryless Source (BMS). List the important observations from the drawn plot. 10

4.(a)(ii) Plot the curve of transition probability versus Channel capacity for a Binary Symmetric Channel (BSC). List the significant observation from the drawn plot. 10

4.(b) (i) Sketch the polar plot for $G(s)\,H(s) = \dfrac{1}{s^4(s+2)}$.

(ii) How do you count the number of encirclements of the

(A) Origin

(B) $(-1 + j0)$

points ? Use examples to justify the answer. 12+4×2=20

4.(c) A demand paged virtual memory system uses 4 page frames. Consider following string of memory references :

1 2 4 0 5 7 4 3 4 0

Indicate the page frames for the reference string and determine the number of page faults for

(i) FIFO (First In First Out) page replacement algorithm

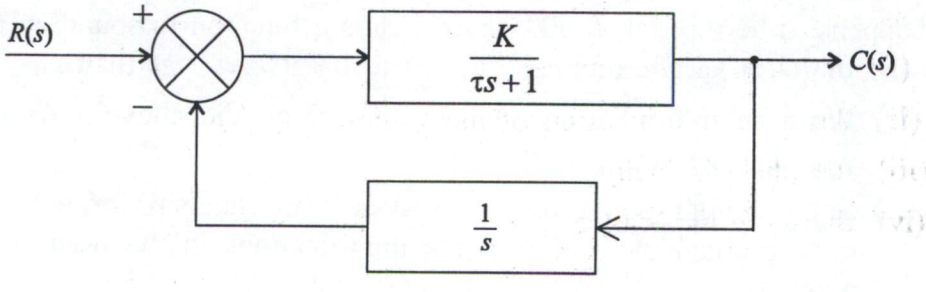
(ii) LRU (Least Recently Used) page replacement algorithm 10+10

SECTION 'B'

5.(a) Consider a telephone channel having a bandwidth of 3 kHz and the channel capacity of 30 kbps. Calculate the Signal-to-Noise ratio of this digital telephone communication system. 10

5.(b) Figure approximately represents a differentiator. Its transfer function $\dfrac{C(s)}{R(s)} = \dfrac{Ks}{s(\tau s+1)+K}$. Note that $\lim\limits_{\tau \to 0,\, K \to \infty} \dfrac{C(s)}{R(s)} = s$.

Find the step, ramp and parabolic error constants for this system, where the ideal system is assumed to be a differentiator.



10

5.(c) Draw precedence graph for the schedule of transactions X, Y, and Z shown below and find if the schedule is conflict serializable ?

X	Y	Z
Read (A) Write (B)		
	Read (C) Write (A) Write (C) Commit	
Read (B) Write (A) Commit		
		Write (A) Commit

$\downarrow$ *time*

10

5.(d) Find the maximum effective area of a $\lambda/2$ wire dipole operating at 300 MHz. How much power is received with an incident plane wave of strength 2 mV/m ?

5+5=10

5.(e) Show that the accumulator is the inverse system of a backward difference system.

10

5.(f) A double-heterojunction InGaAsP light emitting diode (LED) used in a Fiber optic communication system emitting a peak wavelength of 1310 nm has radiative and non radiative recombination times of 30 ns and 100 ns respectively. The drive current is 40 mA.

Calculate :

(i) Bulk recombination life time

(ii) Internal Quantum efficiency

(iii) Internal power of the LED

3+3+4=10

6.(a) The z-component of magnetic field for the dominant mode propagating in air-filled waveguide in the z-direction at 10 GHz is given by the following expression :

$H_z(x, z) = 10 \cos(43{\cdot}74\ \pi x)\ e^{-j\beta_z Z}$, A/m

Find :

(i) the cutoff wave number

(ii) the broader dimension of the guide

(iii) the phase velocity

(iv) the wave impedance

5+5+5+5=20

6.(b) Using overlap add method of block filtering find the output of a filter with impulse response $h[n]=\left\{\underset{\uparrow}{2},\ 2,\ 0,\ 0....\right\}$ and input $x[n]=\left\{\underset{\uparrow}{1},\ -2,\ 3,\ 0,\ -1,\ 2\right\}$.

Take L(value of nonoverlapping blocks) = 3. 20

6.(c)(i) The loss computed for a single-mode optical fiber cable is given as 0·25 dB/km. Determine the optical power at a distance 100 km from a light source of 0·1 mW. 10

6.(c)(ii) Consider that 6 GHz is the receiving frequency at satellite transponder from the earth station and 4 GHz is the output frequency of the satellite transponder. Draw the block diagram of the satellite transponder and explain the functionality of each block. 10

7.(a) Given a uniform plane wave in air as

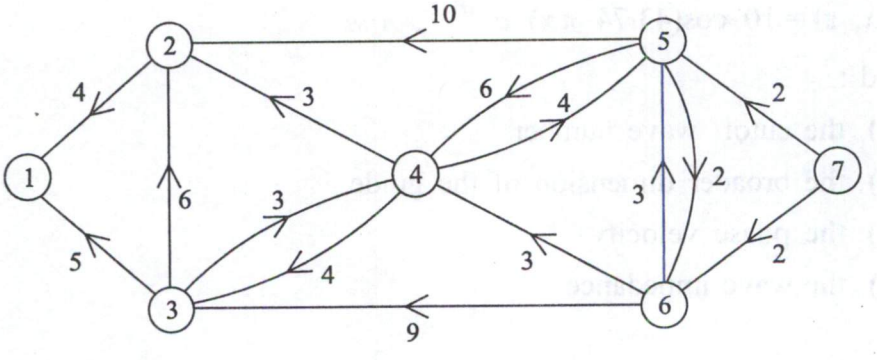
$\vec{E_i} = 40\cos(\omega t-\beta z)\hat{a}_x + 30\sin(\omega t-\beta z)\hat{a}_y$, V/m.

Find $\vec{H_i}$. If the wave encounters a perfectly conducting plate normal to the z-axis at $z=0$, find the reflected wave $\vec{E_r}$ and $\vec{H_r}$. Assume $\epsilon_r = 1$. 20

7.(b) A light bulb L turns ON and OFF depending on the positions of two switches P and Q. P and Q never change positions simultaneously. L is OFF when P is in OFF position irrespective of the position of switch Q. L turns ON when Q toggles its position while P is in ON position, and then remains ON until P goes to OFF position.

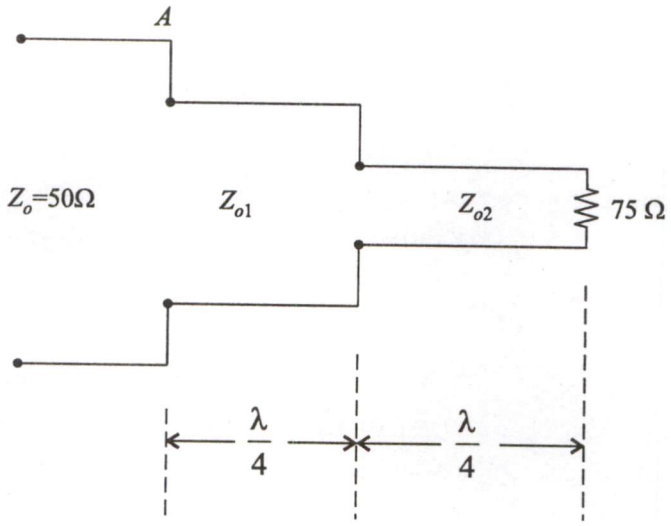
Design an asynchronous circuit to implement the above logic. Derive the minimal-sum Boolean expressions for the output and next state variables in terms of the inputs and present state variables. 20

7.(c) Find the shortest path tree from every node to node 1 for the graph of figure shown using the Bellman-Ford and Dijkstra algorithms.



10+10=20

8.(a)(i) Two $\lambda/4$ transformers in tandem are to connect a 50 Ω line to a 75 Ω load as given below :



Determine the characteristic impedance Z_{o1} if $Z_{o2} = 30\ \Omega$ and there is no reflected wave to the left of A. 10

8.(a)(ii) A distortionless transmission line operating at 250 MHz has $R = 30\ \Omega/m$, $L = 200$ nH/m and $C = 80$ pF/m. After how many meters travelling along the line, will the voltage wave get reduced to 30% of its initial value. 10

8.(b) A data byte read from port 0 of 8051 microcontroller is to be sent out serially from bit 0 of port 1. Each bit duration for serial transmission is 2 milliseconds and least significant bit goes out first. Write assembly language program using timer 0 for the delay. Assume crystal clock frequency to be 12 MHz. 20

8.(c)(i) The downlink of a satellite communication operated at 4 GHz, the receiving antenna is a parabolic reflector with a diameter of 3·6 m and efficiency is 0·7. Calculate the gain of the receiving antenna in dB. 10

8.(c)(ii) The numerical aperture of an optical fiber is 0·3. Calculate the acceptance angle for the meridional rays. Further calculate the acceptance angle for the skew rays which change direction by 90° at each reflection.
(Assume that refractive index, n_a of air is 1) 10
