ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: Three Hours *Maximum Marks : 200*

Candidates should attempt question No. 1 which is compulsory arid any four of the remaining questions.

Some useful constants are given below. Some useful data:

Electron charge: 1.6×10^{-19} Coulomb.
Free space permittivity: $1/36\pi \times 10^{9}$ F/m.
Boltzmann constant : 1.38×10^{-23} J/K
Free space permeability: $4\pi \times 10^{-7}$ H/m.
Velocity of light in free space : 3×10^{8} m/s.
Planck's constant : 6.626×10^{-34} J-s.

1. (a) A quartz crystal has a charge sensitivity of 2pC/N, $\varepsilon_r = 4.5$, diameter of 10 mm and thickness 2 mm. What is its voltage sensitivity? Find the output voltage due to an applied force of 100 N.

(Young's modulus = 9×10^{10} N/m^2)

(8)

(b) A germanium diode has reverse saturation current of 30 μA at 125°C. What are its dynamic forward and reverse resistances for a bias 0.2 V at this temperature ?

(8)

(c) The Fourier transforms of the input and output of a linear time invariant system are $\frac{e^{-j\pi\omega}}{(1+j\omega)}$ and $\frac{e^{-2j\pi\omega}}{(1-\omega^2+2j\omega)}$ respectively. What is its impulse response?

(8)

(d) Verify Tellegan's theorem for the circuit of Fig. 1 (d).

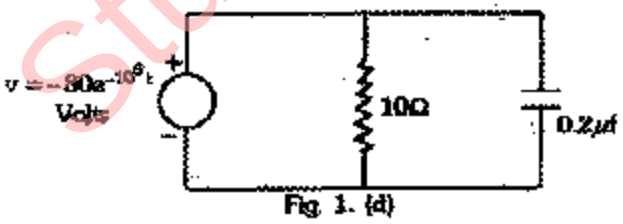


Fig. 1. (d)

(8)

(e) The electric field intensity in air is given by:

$$E = \frac{Sin\theta}{r}\cos\left(6\times10^{7}t - \beta r\right)a_{\phi}\ V/m$$

Determine β and H.

(8)

(f) For a distortionless line with $\gamma = 0.04 + j1.5/m$, $Z_0 = 80\Omega$ and f = 500 MHz, determine the primary constants R, G, L and C.

(8)

(g) Determine the Laplace transform of the periodic function shown in Fig. 1 (g).

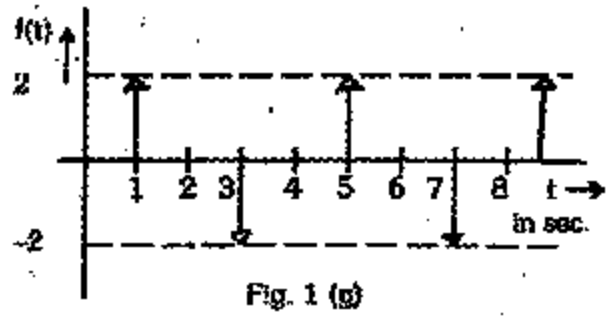


Fig. 1 (g)

(8)

(h) A moving-iron voltmeter has a resistance of 10000 and inductance of 0.765 H. The instrument is calibrated with full scale deflection on 50 V-DC. Calculate the percentage error when the instrument is used to measure 50 V at 50 Hz.

(8)

2. (a) A dielectric material contains 2×10^9 polar molecules / m^3, each of dipole moment 1.8×10^{-27} C–m. Assuming that all the dipoles are aligned in the direction of the electric field $E = 10^5\ a_x$ V/m, find the polarization, the electric susceptibility and the relative permittivity.

(17)

(b) Two washerlike ferrite disks, each having a 24 mm inner diameter, a 36 mm outer diameter and 6 mm thickness, are laid on top of each other so that they have a common axis. One disk has $\mu_r = 15$ and the other has $\mu_r = 30$. A coil of 1200 turns links both of them and produces a_ϕ flux in the a direction. If a current of 10 mA exists in the coil, what is the total flux in the core? What is the inductance of the system?

(17)

3. (a) A p-type silicon sample is placed in a magnetic field as shown in Fig. 3 (a). The applied electric field is $-750\ a_x$ V/m. The electron and hole mobilities are 0.14 and 0.05 $m^2/V–s$ respectively at the operating temperature. Find the magnitudes of

(i) the voltage across the sample length (ii) the drift velocity (iii) the transverse force per coulomb of moving charge due to B (iv) the transverse electric field intensity (v) the Hall voltage

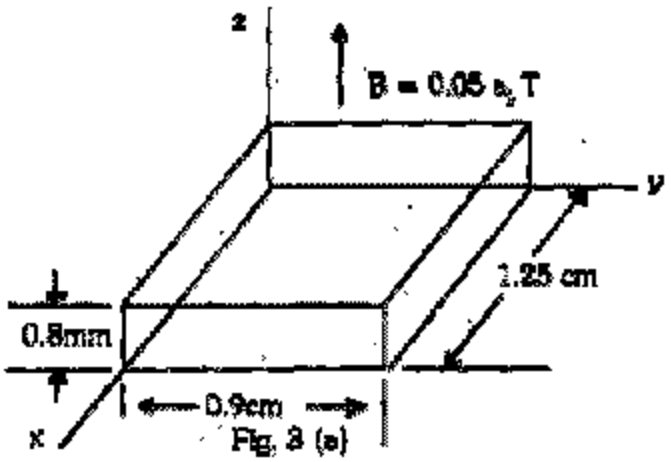


Fig. 3 (a)

(b) An LED with minimum and maximum voltage drops of 1.8 V and 3 V respectively is connected to a 24 V supply in series with a 820 Ω resistor. An identical LED is connected to a 10 V supply in series with a resistor of 120 Ω. Determine which arrangement is preferable from the point of view of constant brightness from the LED.

(17)

4. (a) The complex exponential Fourier series representation of a signal f(t) over the interval (O,T) is

$$f(t) = \sum_{n=-\infty}^{\infty} \frac{3}{4 + (n\pi)^2} e^{jn\pi}$$

(i) Determine the numerical value of T.

(ii) One of the components of f(t) is A cos 3 π t. What is the numerical value of A?

(iii) Find the minimum number of terms which must be retained in the representation in order to include 99.9% of the energy of f(t) in the interval. (Assume signal energy as 0.669 over the period).

(17)

(b) A discrete system has the unit pulse response:

h (nT) = {3, 2, 1, 0, 0, 0, 0 , ... }

(17)

Determine its response for the input:

x (nT) = {1, 1, 2, 2, 1, 1, 0, 0, 0, 0, ... }

(17)

5. (a) Find the transmission parameters for the network of Fig. 5(a).

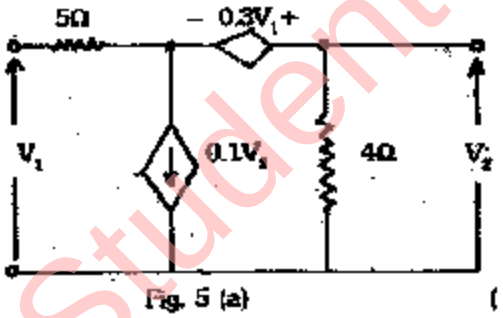


Fig. 5 (a)

(b) The switch in the circuit of Fig. 5 (b) closes at t = 0. Find the current i_A for all times.

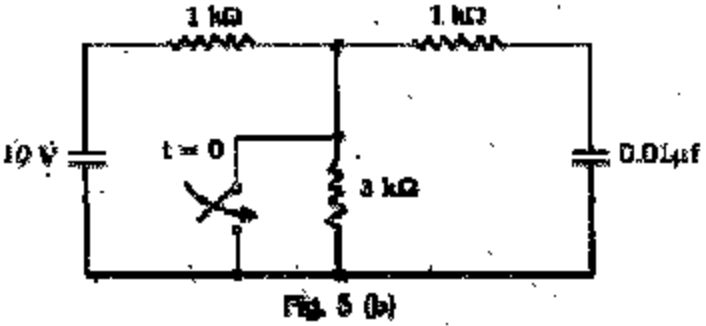


Fig. 5 (b)

6. (a) A lossless air dielectric 50 Ω line is operating with f = 5 MHz. When a load Z_L is connected to it the standing wave ratio is 1.6 and a voltage minimum occurs 8 m to the left of a marked point on the line. If the load is replaced by a short circuit the minimum moves to a spot 3 m to the right of the marked point. Find Z_L . Design a stub to match the load to the line.

(b) The radiation component of the electric field intensity at a point (r, θ, ϕ) due to a current element $I_m \Delta z \cos \omega t \, a_z$ at the origin is:

$$E = j\left(\frac{\frac{60\pi I_m \Delta z \sin\omega}{r\lambda}}{-2\pi r/\lambda}\right) a_\theta V/m$$

Determine the instantaneous electric field intensity and its magnitude at (1000, 0, 0) at t = 0 due to two identical current elements 0.5 cos ωt a_x and 0.5 cos ωt a_y located at the origin if λ = 2 π m. (The location of the point is given in mm rectangular coordinates).

(17)

7. Derive an expression for the electrostatic deflection sensitivity of an oscilloscope. How much deflecting voltage is required to deflect the election beam 1^0 if effective length of deflecting plates is 2 cm, their separation 1 cm and accelerating voltage is 1000 V?

A sine wave voltage is displayed on a CRO. Its vertical amplifier sensitivity is set at 5 V/cm and the time base selector switch is set at a sweep speed of 50 μs/cm. The displayed sine wave has a peak-to-peak amplitude of 5.4 cm and its two complete cycles are accommodated over 8.4 cm of horizontal axis. Determine the r.m.s. value arid the frequency of the input voltage. If voltages Vm_1 cos ωt and Vm_2 sin ωt are applied respectively to the horizontal and vertical deflecting plates of an oscilloscope, prove that the electron beam will trace an ellipse on the screen.

(34)

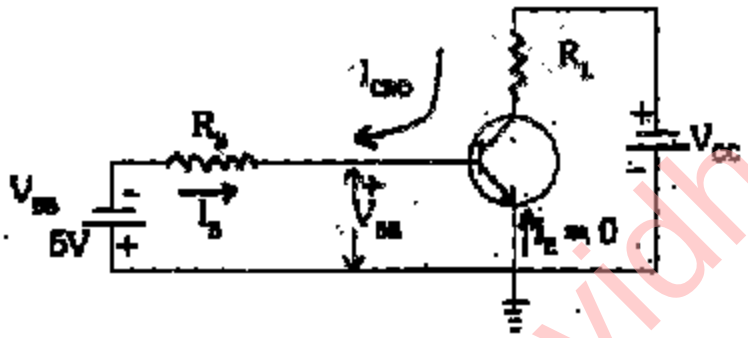
ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: Three Hours *Maximum Marks: 200*

Candidates should attempt question No. 7 which is compulsory and any four of the remaining questions taking TWO each from Section A and Section B.

1. (a) In the transistor circuit shown below I_{CBO} = 2μ Amp at 25° C and doubles for every 10°C increase in temperature.



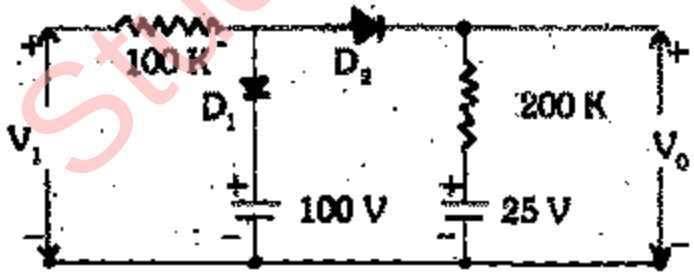
(i) Find maximum allowable value of R_B if the transistor is to remain cut off at 75^0 C. Assume $V_{BE(cut\ off)} = -0.1$ V.

(ii) If V_{BB} = 1.0V and R_B = 50 kΩ how high may the temperature increase before the transistor comes out of cut off?

(8)

(b) The input voltage V_i to the two-level clipper shown below varies linearly from 0 to 150 V. Sketch the output voltage to the same scale as the input voltage. Assume ideal diodes.

(8)



(c) Convert the following pairs of decimal numbers in Excess-3 numbers and perform their addition in Excess-3 codes.

(i) 38, 37 (ii) 129, 131

(8)

(d) Explain what is meant by race-around condition in relation to the J-K flip-flops. Suggest a method of avoiding it.

(8)

(e) Three pole transfer function has all the three poles located at S = – ω.A negative feedback is added with feedback factor β. Show that the system is unstable for $|A_0 \beta| > 8$ where A_0 is the dc gain of the transfer function. Find the value of poles for $|A_0 \beta| = 8$.

(8)

(f) Explain the following terms in relation to television system:

(i) Vestigial sideband (ii) Luminance signals and colour difference (chrominance) signals (iii) Interleaving (iv) Colour sub-carrier burst signal.

(8)

(g) Represent the data bits 101001 by the bipolar NRZ waveform. Sketch the following digital modulation schemes for these waveforms:

(i) Amplitude-Shift Keying (ASK) (ii) Frequency-Shift Keying (FSR) (iii) Phase-Shift Keying (PSK)

(8)

(h) A binary erasure channel matrix is given by

$$\left[P(Y|X)\right] = \begin{bmatrix} 1-P & P & 0 \\ 0 & P & 1-P \end{bmatrix}$$

Draw the channel diagram and if the source has equally likely outputs, compute the probabilities associated with the channel outputs for P = 0.2.

(8)

(i) Determine the required length of a quarter-wave matching section to eliminate standing waves and provide a matched condition for a 300 Ω load fed from a 72 Ω transmission line operating at 100 MHz. Also find the characteristic impedance of the transmission line from which the matching section should be cut. Assume velocity factor = 1.0.

(8)

(j) Explain the two valley model of GaAs Gunn diode. If the electron density and mobility in the lower valley are 10^{14} m^{-3} and 0.8 m^2/V sec respectively and those in the upper valley are 10^{16} m^{-3} and 180×10^{-4} m^2/V sec respectively, calculate conductivity of the diode.

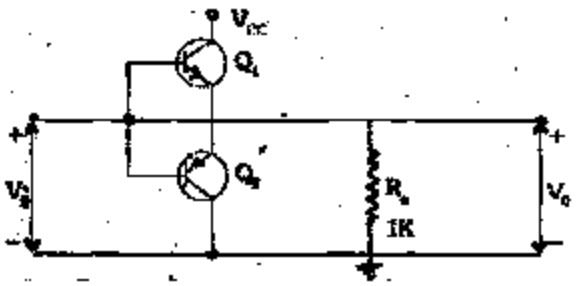
(8)

SECTION A

2. Attempt any two questions:

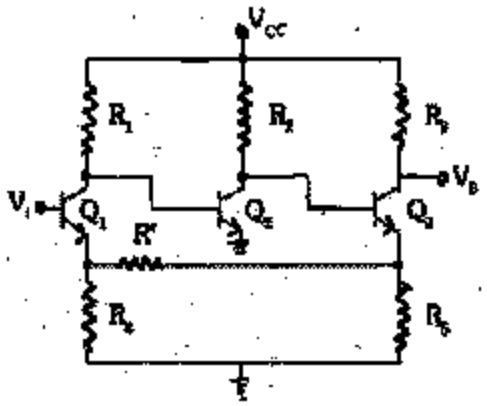
(a) Derive the expressions for the voltage gain A_v and the input resistance R_{in} of the amplifier shown. Find the values of A_v and R_{in} for the following values of h parameters for the transistors:

h_{ie} = 1000 Ω; h_{fe} = 100; h_{re} = h = 0



(15)

(b) For the feedback amplifier shown



(i) draw the circuit without feedback but taking the loading of feedback network into account.

(ii) Find the feedback factor β.

(iii) Assuming loop gain to be much larger than unity, find the voltage gain with feedback.

(15)

3. (a) Draw the circuits for precision half-wave and full-wave rectifiers, using Op-Amps. Explain their working with the help of waveforms and equations.

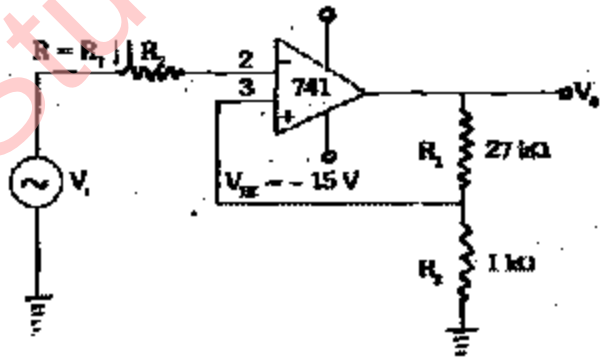
(15)

(b) A regenerative comparator (Schmitt Trigger) circuit is shown below

(i) Derive expressions for upper threshold and lower threshold voltages, V_{UT} and V_{LT} respectively and hence the value of hysteresis voltage V_H. Calculate V_{UT}, V_{LT}, V_H for the given values of R_1 and R_2.

(ii) A sine wave with 2 V peak-to-peak amplitude and 1 kHz frequency is app lied at the input of the circuit. Plot the input and output waveforms.

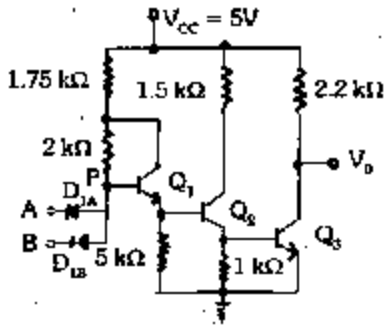
V_{cc} = + 15 V



4. (a) The circuit for an integrated positive diode-transistor-logic (DTL) gate is shown below. The inputs are obtained from outputs of similar gates and its output drives similar gates.

(i) Verify its function as a NAND gate. Specify the state of each transistor for at least one input low and also when both the inputs are high.

(ii) For $h_{FE(min)}$ = 30, calculate the fan-out of this gate. Take $V_{D\ ON}$ = 0.7 V; $V_{CE\ Sat}$ = 0.2 V; $V_{BE\ cut\ in}$ = 0.5V; $V_{BE\ active}$ = 0.7 V; $V_{BE\ Sat}$ = 0.8 V.



(b) Design a parity generator to generate odd and even parity bits for 4-bit code words. Use EX-OR and EX-NOR gates.

(10)

5. (a) What is the delay time of N-stage ripple counter and that of N-stage synchronous counter?

Prepare a truth table and draw logic diagram for a 4-stage binary ripple counter using J-K flip-flops.

Illustrate with logic equation and diagram how its counter can be made to count both in up and down directions.

(15)

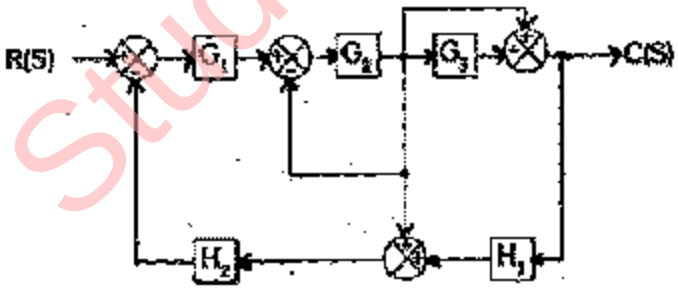
(b) Draw schematic diagram of an A/D converter using voltage-to-time conversion. Explain its working with the help of timing waveforms.

(15)

SECTION B

6. Attempt any **two** questions.

(a) Obtain the transfer function $\frac{C(S)}{R(S)}$ for the multi-loop control system shown.



(15)

(b) A unity feedback control system has a forward transfer function $\frac{25}{s(s+6)}$. Find the resonance peak and the corresponding frequency for the closed loop frequency response. Derive the formula you used.

(15)

7. (a) Eight message signals having 2 kHz bandwidth each are time-division multiplexed, using binary PCM. The error in sampling amplitude cannot be greater than 1% of the peak amplitude. Determine the minimum transmission bandwidth required if raised-cosine pulses with roll-off factor $\alpha = 0.2$ are used. The sampling rate must be at heat 25% above the Nyquist rate.

(14)

(b) Explain the following in relation to satellite communication:

(i) Limits of visibility (ii) Uplink and Downlink transmission bands in C and Ku band (iii) Transponder (iv). Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA).

(16)

8. (a) A code has the panty-check matrix parity-check

$$H = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 \end{bmatrix}$$

(i) Determine the generator matrix G.

(ii) Find the code word that begins 101...

(iii) Decode the received word 110110.

(15)

(b) An optical step-index fibre has a core refractive index 1.55 and core diameter 50 μm and is used at a light wavelength 0.80 μm. Find its V number and the approximate number of modes it will propagate. Refractive index for cladding is 1.51.

(15)

9. (a) Draw the schematic diagram of a helix-travelling wave tube and describe its working. Discuss the features of $\omega - \beta$ diagram. Derive an expression for the output power gain of the tube.

(20)

(b) Describe the physical structure of BARIT diode. Draw its energy band diagram in equilibrium and under bias kg/cm^2, conditions. Discuss its operating principles.

(10)

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