ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time allowed : Three Hours ***Maximum Marks : 200***

Candidates should attempt question No. 1 which is compulsory

and any FOUR of the remaining questions.

Assume suitable data, if necessary, but indicated them clearly.

1. (a) If each of the resistances in the network shown in Fig. 1 (a) is R, what is the resistance between the terminals A and B?

(8)

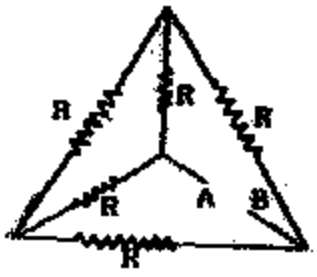


Fig. 1(a)

(b) The values of capacitance of a parallel-plate capacitor with vacuum and with dielectric medium in between the plates are 3.0 μf and 4.5 μf respectively. Calculate the velocity of electromagnetic wave in the dielectric medium.

(8)

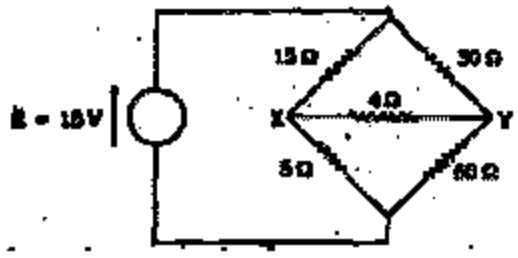
(c) An automotive radar operates at a frequency of 8 GHz. Determine the Doppler shift due to an automobile directly approaching the radar at a speed of 160 Km per hours.

(8)

(d) In a CRT, 3×10^{17} electrons are accelerated through a potential difference of 10,000 V over a distance of 40 mm per minute. Calculate the average power supplied to the beam of electrons.

(8)

(e) Assuming the internal resistance of the voltage source tto



(f) Calcium has a face-centered cubic structure with an ionic radius of 1.06 A. Calculate the inter-planar separation for (111) plane.

(8)

(g) For a half-wave rectifier circuit, find the required a.c. voltage for getting a d.c value of 150 V. The source and load resistances are 25 KΩ and 75 KΩ respectively.

(8)

(h) A semiconductor thermistor having a resistance of 4567 Ω at 300^0 K obeys the relation:

$R_T = R_A \exp (B/T)$, where R_A and B are constants, R_T is the resistance at any Kelvin temperature T. The resistance measured at 303° K was 4134 Ω. Calculate the value of resistance at 318° K.

(8)

2. (a) Two circular conducting plates of radius 25 cm are separated in air by 2mm, and a potential of 100 V is applied between them. Find the capacitance, the stored change, the stored energy and the force existing between the plates.

(17)

(b) A charge Q is uniformly distributed between the spheres of radius r_2 and r_3 ($r_3 > r_2$) respectively. The spheres may be assumed to be constructed of a plastic material with a relative permittivity of 1.0. Calculate (i) the volume charge density in the region between the spheres and (ii) the electric field produced by this charge distribution for values of 'r'.

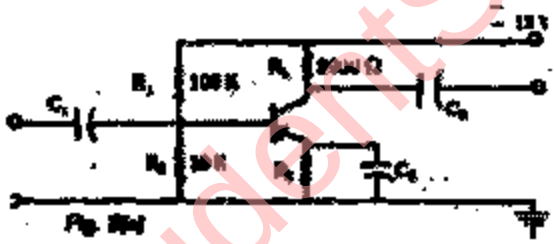
(17)

3. (a) A transistor used in the amplifier circuit show in Fig. 3(a) has the following h-parameters:

$h_{ie} = 800\ \Omega$, $h_{oe} = 50 \times 10^{-6}\ \Omega^{-1}$ and $h_{fe} = 55$.

Calculate the voltage and power gains of circuit. Find also percentage error in the values obtained if h_{oe} is neglected.

(17)

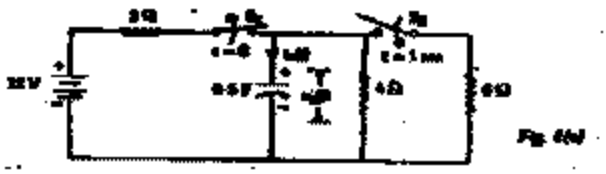


(b) A dipole antenna with a length of 10 cm and carrying a current of 1 A at a frequency of $10^8/2\pi$ Hz, radiates into free space. Find the electric field intensity at a distance of 10 km from the antenna, where conduction field is negligible.

17

4. (a) In the circuit shown in Fig. 4(a) there are two switches S_1 and S_2, S_t opens at time t=O and S_2 closes at time t=1 sec. Determine v_c (t) and i_c (t).

(17)



(b) In a certain series type ohm meter, the indicating meter has a 50 Ω resistance and needs 1 mA for full scale deflection. The ohm meter uses a 3 V battery, a resistor in shunt with the meter and another resistor In series with the battery. The half scale deflection should Indicate 2000Ω.

(i) Calculate the values of the series and shunt resistors,

(ii) the maximum value of the shunt resistor to compensate for a 10% drop in battery voltage. Also calculate the corresponding scale error at half scale mark.

(17)

5. (a) A transmission line is represented by a symmetrical π-network. Calculate the resistance and Inductance (or capacitance) for the series and shunt arms of the π-network, if the line is 10 km long, having characteristic impedance $Z_o = 280\angle 30^o\,\Omega$ and propagation constant, $\gamma = 0.08\angle 40^o$ per loop km. The angular frequency is 5000 rad sec^{-1}.

(17)

(b) Design a rectangular wave guide which at 10 GHz, will operate in TE_{10} mode with 25% safety factor ($f \geq 1.25\ f_c$) when the interior of guide is filled with air. It is required that the mode with the next higher cut-off will operate at 25% below its cut-off frequency.

(17)

6. (a) Synthesize the following impedance function in Foster-I and Cauer-1 forms:

$$Z(S) = \frac{(S^2+4)(S^2+25)}{S(S^2+9)}$$

(17)

(b) A point charge q is situated at a distance d from a grounded conducing plane of infinite extent. Obtain the total charge induced on the plane by direct integration of the surface charge density.

(17)

7. (a) A Schering bridge as shown in Fig 7(a) balances under the following conditions: $R_1 = 10$ KΩ, $R_2 = 1$ KΩ, $C_1 = 100$ μμf and $C_3 = 500$ μμf. The driving frequency is 1 KHz, Find the values of R_x, C_x and dissipation factor D. Also convert these values to parallels equivalent values.

(17)

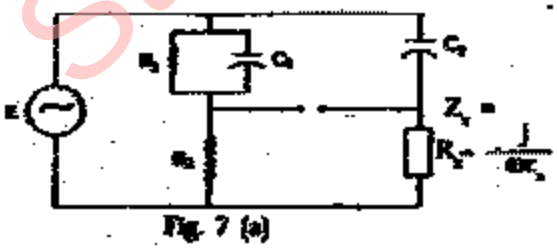


Fig. 7 (a)

(b) By drawing neat diagrams, explain the working of bipolar and field-effect transistors and state their relative merits.

(17)

Some useful contents:

Electronic charge, $e = 1.6 \times 10^{-19}$ C

Electronic mass, $m = 9.1 \times 10^{-31}$ kg

Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}

Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1}

Velocity of light in vacuum, $c = 3 \times 10^{8}$ ms^{-1}

Boltzmann constant, $k = 1.38 \times 10^{-23}$ JK^{-1}

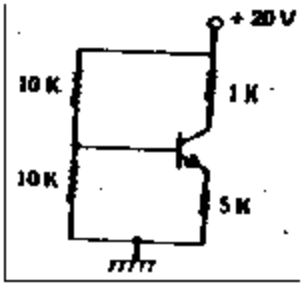
ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: Three Hours ***Maximum Marks: 200***

1. (a) Calculate the emitter current in the voltage divider bias circuit shown. What is the value of V_{CE} and V_C? Make reasonable assumptions.

(6)



(b) The first and the second stage of a two stage RC coupled amplifier have the lower cut off frequencies to be 100 Hz and 200 Hz respectively. Their upper cut off frequencies are 140 KHz and 100 KHz respectively. Find the overall 3 dB bandwidth of the amplifier.

(6)

(c) A decimal number, N, was encoded using seven-bit even parity Hamming code. After transmission, it was received as 1101101. Is there any error introduced dining transmission? What the value of N?

(6)

(d) A six-bit A/D converter has a maximum precision supply voltage of 20 V. What voltage change does each LSB represent? What voltage does 100110 represent?

(6)

(e) Sketch the desirable range of the location of the poles of the transfer function of a system if the system's damping ratio is to lie between 0.3 and 0.7 and its natural frequency is to lie between 2 and 4 rad/sec.

(6)

(f) Draw a signal flow graph for the following equations:

$$x_2 = t_{12}x_1 + t_{32}x_3$$

$$x_2 = t_{23}x_2 + t_{43}x_4$$

$$x_4 = t_{24}x_2 + t_{34}x_3 + t_{44}x_4$$

$$x_5 = t_{25}x_2 + t_{45}x_4$$

(g) In a receiver the antenna is coupled directly at the input to the mixer. The loaded Q of the coupling circuit is 250. If the IF is 455 KHz, determine the image frequency and its rejection ratio at 1 MHz. How does it deteriorate at 20 MHz?

(6)

(h) A receiver connected to an antenna whose resistance is 50 Ω has an equivalent noise resistance of 30Ω . Calculate the receiver's noise figure in decibels and its equivalent noise temperature

(6)

(i) An air filled rectangular waveguide of inside dimensions 7 x 3.5 cm operates in the dominant TE_{10} mode.

(i) Find the cut off frequency.

(ii) Determine the phase velocity of the wave in the guide at a frequency of 3.5 GHz.

(iii) Determine the guided wavelength at the same frequency.

(6)

(j) A (200 + j75) Ω load is to be matched to a 300 Ω line to give SWR = 1. Calculate the reactance of the stub and the characteristic impedance of the quarter wave transformer, both connected directly to the load.

(6)

SECTION A

(Attempt any TWO questions)

2. (a) Sketch the response of a high pass RC circuit when square wave of frequency f is applied at its input. Derive an expression for the % age tilt.

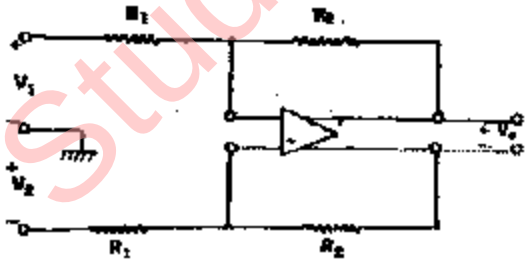
(15)

(b) Draw the circuit diagram of a Schmitt Trigger using transistors and explain its working with reference to the transfer characteristics for various values of loop gain.

(10)

(c) Find the output voltage in terms of V_1, V_2, R_1 and R_2 far the differential input amplifier consisting of a base amplifier of infinite gain as show in the figure below.

(10)



3. (a). Show that if two identical FETs are connected in parallel, then g_m is double and r_d is half of that of individual FET. If two FETs are not identical show that

$$\frac{1}{r_d} = \frac{1}{r_{dl}} + \frac{1}{r_{d2}}$$

and $$\mu = \frac{\mu_1 r_{d2} + \mu_2 r_{d1}}{r_{d1} + r_{d2}}$$

(8)

(b) What are the advantages of push pull arrangement in amplifiers? Draw the circuit of a class-B push pull amplifier and derive an expression for its maximum possible circuit efficiency.

(12)

(c) Specify the truth table for a half subtractor circuit and realize the circuit using AND-OR gates. How two half subtractors can be combined to obtain a full subtractor? Using half subtractor and full subtractors draw and explain the block schematic of a 4-hit parallel binary subtractor.

(15)

4. (a) Design a pulse mode circuit with inputs x_1, x_2, x_3 and output a The output must change from O to 1 if and only if the input sequence x_1 - x_2 - x_3 occurs while Z = 0. The output must change from 1 to 0 only after an x_2 input occurs.

(20)

(b) Design a synchronous counter using JK flip flops which counts in the sequence 0, 1, 2, 3, 4, 0....

(15)

5. (a) A system has unit step response. as shown below.

(i) What is its impulse response ?

(ii) What is the response of the system to the Input function show in the figure?

(15)

Step Response Input function

(b) Consider a feedback control system with the open loop transfer function

$$G(s) = \frac{K}{s(s+1)}$$

Design a series compensator to provide the following specification:

(i) The phase margin of the system must be greater than 45°.

(ii) When the input to the system is a ramp, the steady state error of the output in position should be less then 0.1 degree/deg/ set of the final output velocity.

(20)

SECTION B

(Attempt any TWO questions)

6. (a) Draw the circuit of a balanced modulator and prove that this circuit produces an output consisting of side bands only, with the carrier removed. Also sketch the output wave shape. What application can this circuit have other than SSB generation.

(15)

(b) Draw the circuit of a reactance modulator using an FET and derive an expression for the equivalent capacitance in terms of the frequency of operation a ratio of X_c to R.

(12)

(c) The mutual conductance of an Ff, varies linearly with gate voltage between the limits of 0 and 9 mho. The FET Is used a capacitive reactance modulator, with $X_{cgd} = 8\ R_{gs}$, and is placed across an oscillator circuit which is tuned to 50 MHz by a 50 pF fixed capacitor. What will be the total frequency variation when the trans-conductance of the PET varied from zero to maximum by the modulating voltage?

(8)

7. (a) Describe briefly Shanon Fano Algorithm for efficient encoding of messages. Using this algorithm, obtain the code for a source emitting eight message with probability 1/ 2, 1/8, 1/8, 1/16, 1/16, 1/16, 1/32, and 1/32. Calculate the average information per message and the efficiency of the code.

(15)

(b) Give a brief account of binary digital modulation system used for radio transmission of digital signals.

(8)

(c) Describe in detail an antenna used for TV transmission. How are audio as well as video signals transmitted over the same antenna?

(12)

8. (a) What is a Magic Tee? What are its characteristics? How does its S matrix look like? What are its applications?

(10)

(b) Draw the schematic diagram of a reflex Klystron and explain the phenomenon of velocity modulation

(10)

(c) Discuss briefly the physical structure of a READ diode. Sketch the field distribution and the variation of currents when an a.c. voltage is applied. Derive an expression for the resonant frequency.

(15)

9. Write brief notes on the following:

(a) Hartley Oscillator

(7)

(b) Programmable Logic Arrays

(7)

(c) Root Contours

(7)

(d) Packet Switched Digital Network

(7)

(e) Cavity Magnetron

(7)