ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: Three Hours *Maximum marks 200*

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

1. (a) Consider the circuit of Fig 1a. The diode is ideal. The input waveform is as shown. Find the voltage across the capacitor at 1 ms, 3 ms, 6 ms and 9 ms.

(8)

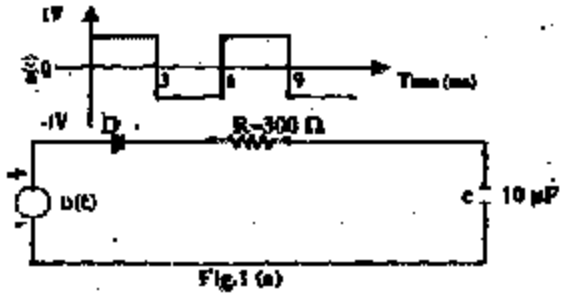


Fig. 1 (a)

(b) A p-type material has an acceptor ion concentration of 1×10^{16} per cm^3. Its intrinsic carrier concentration is $1.48 \times 10^{10}/cm^3$. The hole and electron mobilities are 0.05 m^2/V-s and 0.13 m^2/ V-s respectively. Calculate the resistivity of the materials:

(8)

(c) Investigate the following functions for their realizability as R-C driving point impedance function. Give reasons in support of your answers.

(8)

(i) $\dfrac{(s+1)(s+3)}{s^2(s+2)}$ (ii) $\dfrac{(s-1)(s-3)}{(s-2)(s-4)}$

(d) A 5 μF capacitor charged to 100V discharges through a 300 ohm resistor. Write an expression for the power flow into the resistor. Find the total energy transferred to the resistor over an infinitely long time.

(8)

(e) Consider a three-lossless-transmission line system as shown in Fig 1e. The lengths and the characteristic impedances are also shown in the figure. Determine the characteristic impedance of the quarter-wave (B) line for matching on line (A). What will be the VSWR on line A if the line B is not used?

(8)

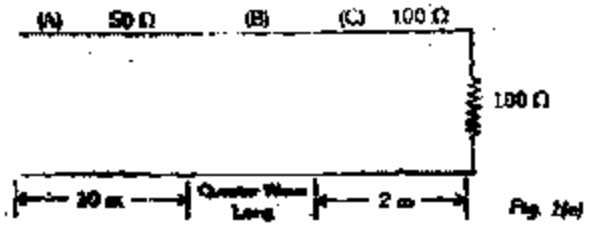


Fig. 1(e)

(f) Find the current required to radiate 100W of power at 100 MHz from a 10 cm Hertzian dipole. Also find the electric field intensity at a distance of 100 m at a point lying in the plane perpendicular to the dipole and passing through its centre.

(8)

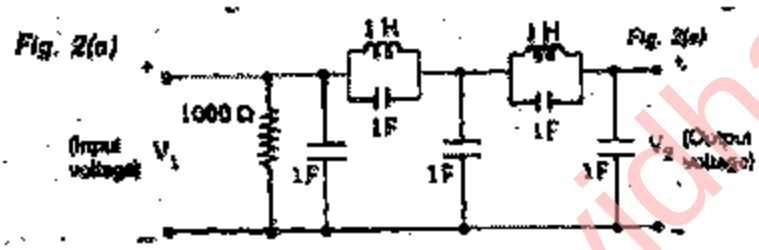
(g) The electric field intensity at a point on a conductor surface is $E=2a_x - 0.9a + 1.5a_z$ V/m where a_x a_y and a_z are unit vectors along x, y and z directions. Determine the surface charge density at the point. What should be the sign (i.e. positive or. negative)? Why?

(8)

(h) A resistance strain gauge with a gauge factor 3.0 is mounted on a beam whose modulus of elasticity is 2.1×10^6 kg/cm^2. The strain gauge nominal resistance of 120 ohm increases to 120.2 ohm when the beam is subjected to stress. Calculate the stress.

(8)

2. (a) Write the properties of the numerator polynomial of the voltage transfer function of a passive two port network. Also determine the voltage transfer function of the network of fig. 2a



(b) For the JFET in the circuit of Fig 2b:

(17)

$I_{DSS} = 5$mA; $V_{po} = 3$V with usual notations.

Also in this circuit

$R_D = 2k\Omega$; $R_s = 8K\Omega$;

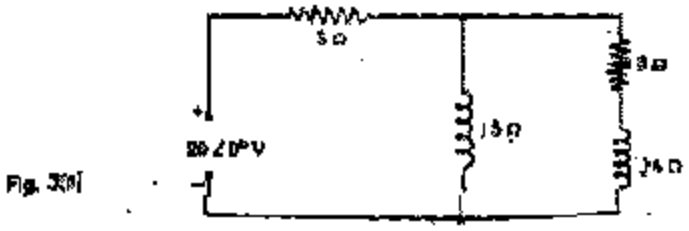
$V_{DD} = 15$V; $V_G = 10$V;

and $V_{SS} = -8$V.

Calculate V_{GS} and V_O.

3. (a) In the circuit of Fig. 3a, the 5Ω resistor is changed to 8 Ω. Use compensation theorem to find the change in current through the 3 W resistor.

(17)



(b) A 5.2 V Zener diode has a maximum power dissipation of 260 mW. It maintains a constant voltage when the current though the diode does not fall below 10% of the maximum permissible currents. A 15 V supply is given to the Zener through a series resistor R. Find the range for R so that the Zener maintains its constant voltage. Find the new range when the diode is loaded by 50 Ω load.

(17)

4. (a) A parabolic reflector has an aperture efficiency of 0.55 and a directivity of 30 dB at 300 MHz. Calculate the diameter and half power beam width. What will be the gain and beam width if the frequency changes to 200 MHz?

(17)

(b) Determine the Thevenin's equivalent circuit referred to left of the points A and B in the circuit of Fig. 4b and then calculate the power fed to the 12Ω resistor.

(17)

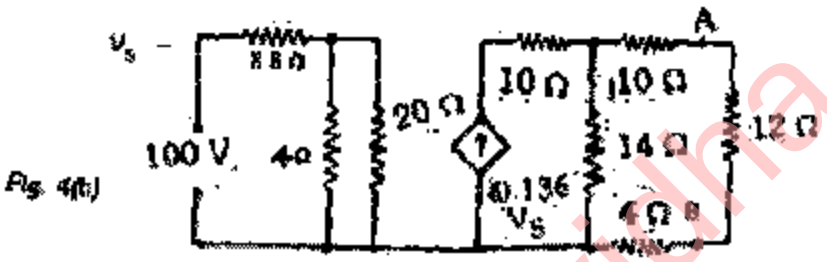


Fig. 4(b)

5. An air dielectric L-band rectangular waveguide with width-to-height ratio of 2.0 has a dominant mode cutoff frequency of 0.908 GHz. The guide wavelength is 40 cm and the excitation is 5000 V/m. Name the dominant mode and calculate the frequency of operation, the guide width and the height, the phase shift constant and the power flow.

(34)

6. (a) A silicon diode showed currents of 2 mA and 10 mA respectively when the diode voltages were 0.6 V and 0.7V. Estimate the operating temperature of the diode junction.

(17)

(b) Describe a method of measuring the distributed capacitance of a coil. Derive the necessary expression. State the necessary precautions, if any.

(17)

7. (a) A parallel plate capacitor with 1.0 cm separation between plates has 20 kV applied across it. It has air dielectric. A glass sheet of 2 mm. thickness and of 6.5 relative permittivity is inserted in the air dialectic and kept on one plate. Find the capacitance of the parallel plates with the glass per unit area, the electric field in air and glass, and the charge density the plates.

(17)

(b) Describe Hay bridge. Derive expressions for the unknown parameters. What are die merits or limitations of the bridge? Should the frequency of the excitation be known? Why?

(17)

Some useful constants:

Electron charge	: 1.6×10^{-19} coulomb
Boltzmann constant	: 1.381×10^{-23} Joule/K
Planck's constant	: 6.626×10^{-34} Joule /Sec.

Avogadro's number	:	6.023×10^{26} /Kmol
Permittivity of free space	:	8.85×10^{-12} F/m
Permeability of free space	:	$4\pi \times 10^{-7}$ H/m
Velocity of light in free space	:	3×10^{8} m/s

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time allowed: Three Hours *Maximum Marks: 200*

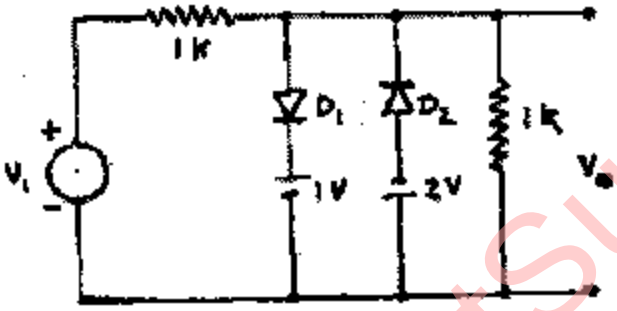
Candidates should attempt question No. 1 which is compulsory and **FOUR** more questions taking **TWO** each from Section A and Section B.

1. (a) A transistor's maximum average dissipation capability is 2.5 W. When used in α class A direct coupled power amplifier, find (1) the maximum a.c. power deliverable to the load, and (ii) the minimum d.c. power needed from the power supply to provide the power in part (i).

(6)

(b) Draw the transfer characteristic for the given circuit, assuming ideal diodes.

(6)



(c) The input frequency of a 6-bit binary rate multiplier (7497) is 128 kHz. What will be its output if the multiplier word is 1011? How can 12-bit rate multiplication be achieved using two 6 bit binary rate multipliers?

(6)

(d) X and Y are successive digits i a positional number system. Also, XY $25_{(10)}$ and YX = $31_{(10)}$ Determine the radix value of the system and values of X and Y.

(6)

(e) What are the advantages of A.C servo motors for use in control systems? Sketch the torque speed characteristics of such a motor for a least three different values of rotor resistance. When can the characteristics be considered straight?

(6)

(f) The open loop transfer function of a system is given below:

$$G(s)H(s)=\frac{K}{s(s+4)(s+5)}$$

For what values of k is the system stable?

(6)

(g) Calculate the capacity of a standard telephone channel with a 32-dB signal to noise ratio.

(6)

(h) A varactor diode has an effective capacitance, C given by $C = 10\,(1\text{-}0.75\ V)^{-1/2}$ pF when V is the bias voltage. The diode is placed in parallel with a 0.75 μH inductor and the combination resonates at 100 MHz. Determine the value of bias voltage, V.

(6)

(i) A lossless line has a characteristic impedance of 50Ω and is terminated in a load resistance of 75Ω. The line is energized by a generator which has an output impedance of 50Ω and an open circuit output voltage of 30 V (rms). The line is 2.25 wavelengths long Determine.

(i) The input impedance (ii) The instantaneous load voltage (iii) The instantaneous power delivered to the load.

(6)

(j) A waveguide has an internal breadth a = 3 cm, and carries the dominant mode of a signal of unknown frequency. If the characteristic wave impedance is 500 Ω, what is this frequency?

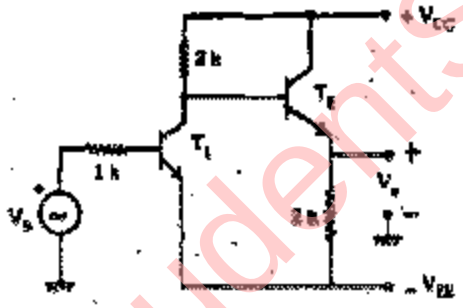
SECTION A

(Attempt any two questions)

2. (a) For the cascaded amplifier shown, find the input impedance, output impedance, current gain, and the voltage gain. Make any reasonable assumption. The h-parameters are:

$h_{ie} = 1.1k\Omega,\ h_{fe} = 50$ (Neglect h_{re}, h_{oe})

(20)



(b) Draw the circuit of an RC phase shift oscillator using and FET. Derive (a) an expression for the frequency of oscillations and (b) the condition for sustained oscillations.

(15)

3. (a) Draw the circuit of an Astable multivibrator using OP AMP (s) and explain it working with the help of waveforms. Derive an expression for frequency of oscillations.

(15)

(b) Design a synchronous sequential circuit, using JK flip flops, with one input line, x and one output line, Z. The circuit is to recognize the occurrence of the sequence 1111 in the input string. Overlapping occurrences are also to be recognized. For example,

if x = 00110 1111 010 111110.....

then Z = 00 000 0001 000 000110.....

(20)

4. (a) Explain the working of a 4-bit R-2R ladder network D/A converter. What are its advantages and disadvantages? Determine the output voltage caused by input of 1101 if $V_R = 5$ volts.

(20)

(b) What is the difference between ROM and RAM? In a three bit addressable ROM, the following functions are desired:

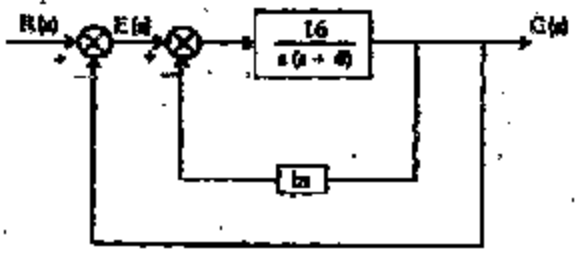
$h_0 = \sum 0, 2, 5, 6,$ $h_1 = \sum 0, 2, 4, 6, 7$

$h_2 = \sum 0, 3, 4, 7,$ $h_3 = \sum 1, 2, 3, 5, 7$

How would you construct it?

(15)

5. (a) The system shown below consists of a unity feedback loop containing a minor rate feedback loop.



(i) Without any rate feedback (b = 0), determine the damping factor, natural resonant frequency, overshoot of the system to a unit step input, and the steady state error resulting from a unit ramp input.

(ii) Determine the rate feedback constant which will increase the equivalent damping factor of the system to 0.8. Determine the overshoot of the system in this case to a unit step input and the steady state error resulting from a unit ramp input.

(b) Using Bode plots, determine the gain margin and phase margin of a unit feedback system having an open loop transfer function.

$$G(s) = \frac{10}{s(0.1s+1)(0.05s+1)}$$

By what constant factor should G(s) be multiplied for (i) a gain margin of 20 dB, and (ii) a phase margin of 24°.

SECTION B

(Attempt any two questions)

6. (a) Derive an expression for a frequency modulated wave when the carrier and the signal are both pure sinusoid. Derive its frequency spectrum and comment on the bandwidth.

(13)

(b) Define the terms selectivity, sensitivity and fidelity with reference to a radio receiver and explain their significance. Explain a method for the measurement of selectivity.

(10)

(c) Define conditional entropy and redundancy. A binary data source has $P_0 = 3/8$, $P_1 = 5/8$, and P(1/0) = 3/4, P(0/1) 1/16. Calculate the conditional entropy and the redundancy.

(12)

7. (a) Draw the block diagram of complete delta modulation system and explain its working. Derive an expression for the output signal-to-quantisation noise ratio.

(20)

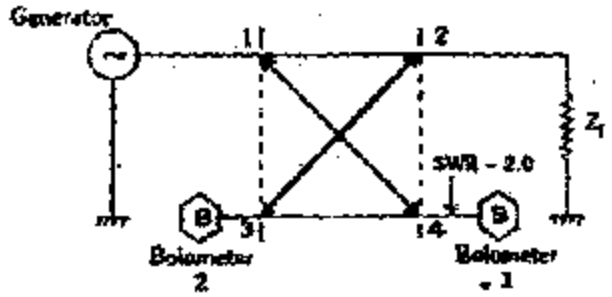
(b) Give an expression for A-low, compression as used commercial PCM telephone systems. What is the typical value of the parameter A? Draw compression characteristic and typical

curves for signal-to-quantisational noise ratio versus the input signal power for systems with and without companding. Discuss the advantages of companding.

(15)

8. (a) A symmetric directional coupler with infinite directivity and a forward attenuation of 20 dB is used to monitor the power delivered to a load Z, as shown below. Bolometer 1 introduces a VSWR of 2.0 on arm 4; bolometer 2 is matched to arm 3. If bolometers 1 reads 8 mW and bolometer 2 reads 2 mW; find: (i) the amount of power dissipated in the load, Z_1 (ii) the VSWR on arm 2.

(20)



(b) Discuss the operation of a microwave tunnel diode with the help of energy band diagrams. Hence obtain the I-V characteristics of the tunnel diode.

(15)

9. Write brief notes on the following:

(5×7=35)

(a) Miller effect and its application (b) Ripple counters and their applications (c) Constant-M and constant-N loci and their significance in system design (d) International standards in colour television System and their intra-compatibility (e) Reflex Klystron and the phenomenon of bunching.