ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed : Three Hours *Maximum Marks : 200*

Candidates should attempt question 1 which is compulsory and any FOUR of the remaining questions

The number of marks carried by each question is indicated a the end of the question

1. (a) A rectangular wire meals of infinite extend in a plane has 1 A of current fed into it at a point A, as Shown below, and 1 A taken from it at point C. Find the current in the wire AC.

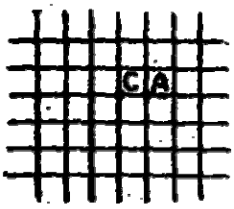

Fig. Q. 1 (a)

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(b) A conductor is charged by repeated contacts with a metal plate which, after each contact, is recharged to a quantity of charge Q. If q is the charge of the conductor after the first operation, what is the ultimate charge on the conductor?

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(c) Given two iron bars, identical in appearance, one magnetized, the other not. State how to distinguish them without using external 'magnetic fields. You are allowed to measure forces.

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(d) A flywheel of radius R, with charge Q uniformly distributed along its rim, rotates with angular velocity to ω. What is the rate which energy is radiated by the system?

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(e) The intrinsic resistivity of germanium at 300^{o} K is 47 ohm-cm. What is its intrinsic earner concentration? Also calculate the drift velocity of holes and of electrons for an electric field E = 100 V/cm. Given : $\mu_n = 0 = 3.9\ m^2/V$ sec and $\mu_p = 0.19\ m^2V$ sec. (Electronic chare e = 1.6×10^{-19} C)

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(f) The edges or a cube consist of equal resistors of resistance R, which are jointed at the corners. Let a battery be connected to two opposite corners of a face of the cube. What is the effective resistance?

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(g) A short current filament is λ/10 In length. Calculate the numerical value of its radiation resistance.

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(h) A 300-ohm transmission line is to feed 72-ohm antenna at 100 Mc. Design a suitable matching section for the transmission line to look into a 300-ohm load.

2. (a) In a full-wave rectifier the value of load resistance is 5000Ω. Each diode has idealized characteristics having slope corresponding to a resistance of 800Ω. Voltage applied to each diode has amplitude of 300 V and frequency equal to 50 Hz. Calculate (i) peak, average and r.m.s. values of current, (ii) d.c. power output and total power input, (iii) rectifier efficiency, (iv) form factor, and (v) ripple factor.

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(b) A transistor in mid-frequency range is represented as shown below. Determine its h-parameters.

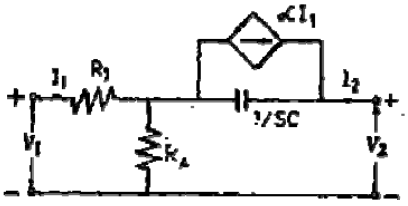

Fig. Q. 2 (b)

3. (a) The potential ψ(x), satisfies Poisson's equation in the barrier region of p-n junction diode with a Schottky barrier. Take the positive x-direction from the p-region to the n-region through the junction x = 0 at the p-side of the transition region and x =d on the n-side. Assume reasonable boundary conditions and calculate the width d, of the transition region, in terms of the donor and acceptor densities the dielectric coefficient ∈, the diffusion potential V_d the applied potential V, and the electronic charge e. Show also that the capacitance per unit area of the junction is ∈/d.

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(b) A sample of germanium shows no Hall effect. If the mobility of electrons in germanium is 3500 cm^2/V sec and that of the holes is 1400 cm^2/V sec, what fraction of the current in the sample is carried by electrons? Prove formula used.

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4. (a) Calculate the readings of ammeter A and voltmeter V in the circuit shown below. The voltmeter is assumed to have infinite resistance and the ammeter zero resistance.

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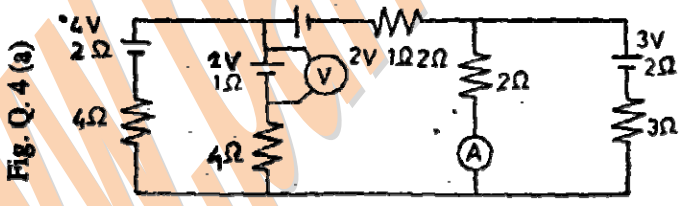

Fig. Q. 4 (a)

(b) A thin dielectric rod of cross-section A extends along the x-axis from x = 0 to x = L The polarization of the rod is along its length, and is given by $P_1 = ax^2 + b$. Find the volume density of polarization charge and the surface polarization charge on each end. Show explicitly that the total bound charge vanishes in this case.

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5. (a) Define a transducer. Give three examples of transducers involving different principles of action. A strain gauge has a gain factor of 4. If this strain gauge is attached to a metal bar that stretches from 25 cm to 25.2 cm, calculate the percentage change in its resistance. If the unstrained value of resistance is 120Ω, what would be its value after strait, is applied?

17

(b) Electrons emitted from a surface A. as shown below, are accelerated toward surface C which is maintained at a potential of +V volts. The separation of the plates is d metre. Show that the value of the flux density B at which current will cease to flow to plate C is given by

$$B = 2mV / ed^2 \Big|^{1/2}$$

where m and e are electronic mass and charge respectively.

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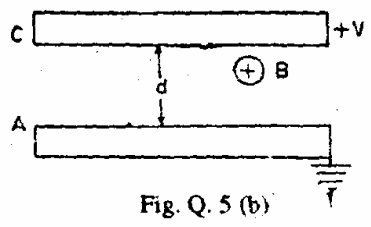

Fig. Q. 5 (b)

6. (a) Design a constant K low pass T and π-section filters to be terminated in 600Ω, having cut-off frequency 3kHz. Also determine (i) the frequency at which the filters offer attenuation of 17.372 dB and (ii) the characteristic impedance and phase constant at 2kHz.

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(b) The switch S, as shown below, remains open for a long time before it is closed at t = t_0 for 50μ sec. It is then opened. Calculate the output voltage e_0 at t=t_0 and at t = 50 μ sec.

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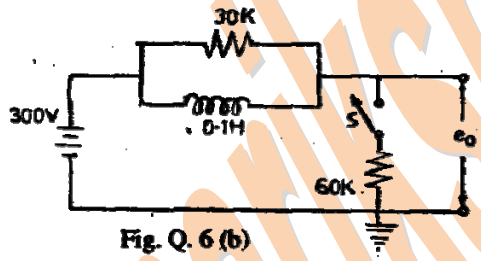

Fig. Q. 6 (b)

7. (a) A lossless transmission line of characteristic impedance 50Ω is terminated at one end in a short-circuit and at the other end in a resistive, impedance of 85Ω as shown below. The impedance measured at the junction AA' is found to be 75Ω resistive, at a frequency of 44 MHz. Calculate the phase velocity in the transmission line.

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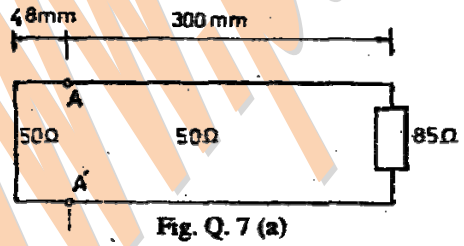

Fig. Q. 7 (a)

(b) A parallel plate capacitor consists of two metal plates of area A and separation d. A slab of thickness t, and dielectric constant ∈ is inserted between the plates with its faces parallel to the plates and having the same surface area as that of the plates. Find the capacitance of the system. If ∈ = 2, for what value of lid will the capacitance of the system be 3/2 Limes that of the air-capacitor alone? If the charge Q in the capacitor remains unchanged, calculate the energy in the two cases and account for the change in energy.

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: Three Hours *Maximum Marks: 200*

*Candidates should attempt any **FIVE** Questions choosing at least TWO from each section*

The number of marks Lamed by each question is indicated at the end of the question.

Answers must be written in English.

SECTION A

1. (a) Find the transistor currents in the circuit of Fig. 1 (a). A silicon transistor with β=100 and I_ω=20 nA is under consideration.

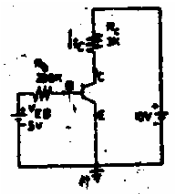

Fig. 1 (a)

Repeat part a if a 2 K emitter resistor is added to the circuit as shown in Fig.(b).

Sketch the small signal high frequency circuit of a common source amplifier. Also, derive the expression for voltage gain

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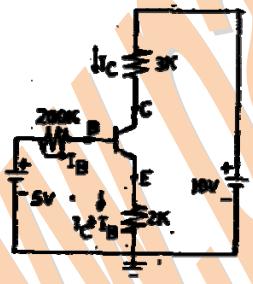

Fig. 1 (b)

(b) Show that the trans-conductance g_m of a JFET is related to the drain current I_{DS} by

$$g_m = 2\sqrt{\frac{I_{DSS} I_{DS}}{|V_P|}}$$

where the symbols have their usual meaning. If V_P = –4V and I_{DSS} = 4 mA plot g_m Versus I_{DS} For a p-channel silicon FET with a = 2×10^{-4} cm and channel resistivity ρ = 10 Ω-cm

(i) find the pinch-off voltage:

(ii) repeat (i) for a p-channel Ge FET with ρ = 2 Ω-cm.

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(c) Draw a CMOS inverter showing positive logic. Draw a MOSFET circuit satisfying the logic equation $Y = \overline{A + BC}$ where Y is the output corresponding to the three inputs A, B and C.

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(d) If an input signal V_1 is impressed- between gate and ground, find the amplification $A_0 = V_0 / V_L$ Apply Miller's theorem to the 50 K resistor. The PET parameters are $\mu = 30$ and $r_d = 5$ K Neglect capacitances.

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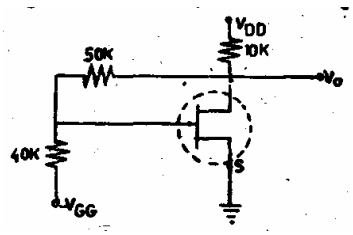

2. (a) How is a FET used as a VVR (voltage variable resistance)? Explain.

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(b) Draw the circuit of the emitter coupled Astable Multivibrator and explain its operation.

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(c) Draw the circuit of a Schmitt trigger (regenerative comparator) and explain its creation. Sketch its transfer characteristics and response to an arbitrary signal.

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(d) Explain with Circuit Schematic the operation of a 4-bit magnitude comparator. Show how one may sort an array of binary numbers.

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3. (a) Discuss in detail, the working of full-adder logic circuit and extend your discussion to explain a binary adder, which can be used to add two binary numbers.

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(b) Draw the circuit diagram of a Master-slave J-K flip-flop using NAND gates. What is race-around condition? How is it eliminated in Master-slave J-K flip-flop?

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(c) Design a modulo 9 asynchronous counter using Master-slave J-K flip-flop?

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(d) Draw the circuit diagram of .a bipolar or MOS difference amplifier. Derive an expression far the voltage gain of the amplifier. What is a current mirror?

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4. (a) Develop the truth table for the decoder.

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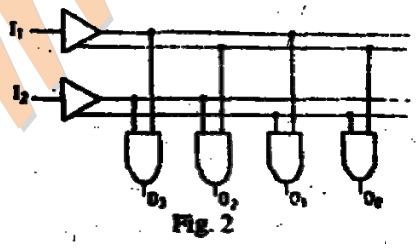

Fig. 2

(b) Explain the working of a R-2R DAC and show how R-2R DAC canverts the binary word 1000100 to an analog output. Find the magnitude of the output, given V_{mf} = 5.0 V.

12

(c) Assume that a floppy disk measures 3.5 inches in diameter and that 50 per cent of its surface area is usable for data storage. If individual cells require a surface area of 2 square units, what maximum number of eight-bit bytes can be stored on the disk? 10

(d) Give the -logic diagram of a 4-bit bidirectional universal shift register. Show how reset, shift left, shift right and parallel load operations may he carried out.

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5. (a) A feedback control system is having a

$$G(s) = \frac{k(s+40)}{s(s+10)}$$

and the feedback transfer function is

$$H(s) = \frac{1}{s+20}$$

Determine the limiting values of k for stable system. If the gain is reduced to 50 per cent of previous value, calculate the –phase margin and gain margin.

20

(b) What are the different method of controlling the speed of a DC motor? Describe one method using SCRs and AC power supply.

12

(c) List the steps in drawing root locus.

8

SECTION B

6. (a) Explain the process of 'Drift space bunching' and 'Reflector bunching' using Applegate diagrams.

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(b) Derive an expression for the electronic-tuning range in a Reflex Klystron Oscillator in terms of the Q of the cavity and Δ^{θ} the small variation in transit angle by varying the Reflector Voltage.

15

(c) In an experiment for the measurement of Reflex Klystron mode characteristics, the following data is obtained:

V_0 = 300 volts (Beam voltage); V_{R1} = –143 volts:

V_{R2} = –105 volts: V_{R3} = –65 volts.

The frequency of operations at the three reflector voltages given above was the same. Evaluate the actual operating mode numbers N_1, N_2 and N_3.

15

7. (a) Describe the different tones used in an automatic telephone exchange.

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(b) Design a cylindrical cavity resonator for use it a parametric amplifier to have the following specifications:

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Resonant Frequency GHz	*Mode of Operation*	U_{mm}
2.80	TE_{011}	$3.832 = u'_{01}$
9.40	TE_{114}	$1.841 = u'_{11}$

(c) A lossless transmission line of $Z_p = 50$ ohms is terminated by a load $Z_3 = 100 + j\ 100$. Using Smith's change, design a single stub matching arrangement to match the load to the Generator and the line. Calculate the position of the short circuited stub and the length of the stub for matching.

(d) Show the trunking diagram of a 5 digit automatic exchange using stronger system and explain the terms 'Full availability' and 'Grade of Service'.

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8. (a) Explain the operation of a typical TV Camera using a Vidicon tube.

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(b) Explain how the sound and picture signals ate separated from the Composite Video Signal in the TV receiver. Give the details of the frequencies used in this connection.

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(c) Explain the principle and working of a GUNN oscillator.

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(d) An MT_1 Radar operates at 10 GHz with PRF of 3000 PPS. Calculate the lowest three blind speeds of this radar.

10

9. (a) Explain with a neat schematic the working of a DPCM system. Compare the advantages and the disadvantages of DPCM with that of PCM.

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(b) State and explain Hartley-Shannon Theorem. Calculate the, amount of information needed to open a lock whose combination consists of three numbers each ranging from 00 to 90.

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(c) Give the. schematic of a Magic-T used in microwave measurements and explain its working. Mention its uses.

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(d) Write a note on microwave solid state devices for (i) low noise amplification and (ii) high power amplification.

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10. Write short notes on any four:

10×4

(a) Phase Locked Loop and its application

(b) Decca and Navigational aids

(c) Magnetrons

(d) Satellite Communication

(e) A/D and D/A Converters

(f) Microwave Antennas

(g) FDMA and TDMA.