ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time allowed : 3 hours *Maximum marks : 200*

Candidate should attempt question 1 and any four of the remaining question.

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

Answers must be written in English.

1. (a) In the figure shown determine the potential difference between the points P and Q in the steady state.

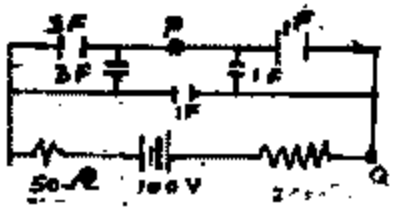

Fig. Q. 1 (a)

(b) You are given a transistor whose terminals are unmarked. State how you will determine if it is a pnp or npn transistor and identify all three, terminals using only a multi-meter.

8

(c) When d.c. current is passed through an iron cored coil, the energy stored in the magnetic field is 1000 joules and the copper loss is 2000 W. What is the time constant of the coil?

8

(d) A CRO with a risetime of 15 ns measures the risetime of a signal as 20 ns. What is the actual risetime?

8

(e) The drain current in milliamperes of the depletion type FET shown is given by

$$I_D = 16\left(1 + \frac{V_{GS}}{4}\right)^2$$

Find the quiescent current I_D.

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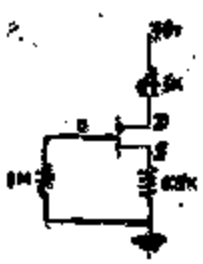

Fig. Q 1 (e)

(f) A straight rod of radius a and infinite length carries a direct current I. Find the vector magnetic potential inside and outside the rod.

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(g) What are vaructor diodes? Give at least two applications of these devices.

(h) Define gain of a antenna of effective area A. If the frequency of the signal is doubled, what is the effect on the gain?

8

2. (a) A parallel plate capacitor has length and width 1 m each and plate separation is 10 mm. Find the energy stored in the capacitor and the force between the plate S if air is filled in the space between the plates and a p.d. of 10 kV applied.

10

(b) A dielectric slab of relative permittivity 6 is now Inserted part of the way between the plates of the above capacitor Calculate the force acting on the end of the slab. Does this force act to push the slab out or to pull it further in?

12

(c) An npn transistor with a_N =0.98, I_{CO}=2 μa and I_{EO}=1.6 μa is used in a common emitter configuration with V_{CC} = 12 and R_C=4k. Find minimum base current required to saturate the transistor and the voltage across each junction. Neglect V_{VE} (sat).

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3. (a) In the figure shown after the 1 V source has been connected lot a very long time, the switch is closed at i=0. Calculate the current in the 3 henry inductor as a function of time.

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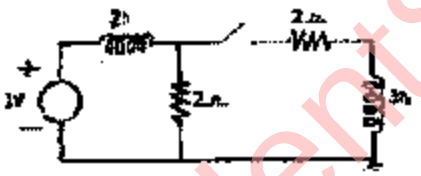

Fig Q. 3 (a)

(b) A square wave of amplitude 1 volt and period 2 sec is connected in series with a resistance of 1 ohm and an inductance of 1 henry at t=0 . Find the current in the circuit.

17

4. (a) A 70 Ω line is to be connected to a 150 Ω load by a section of loss free line of phase constant 5 rad/m. Determine shortest length of this section and be value of the characteristic impedance Z_0 so that there is no reflected wave on the 70 Ω line.

17

(b) In the circuit shown, Q_1 and Q_2 are identical transistors with current gain β and Q_2 has current gain β'. Determine the relation between I_2 and I_o.

17

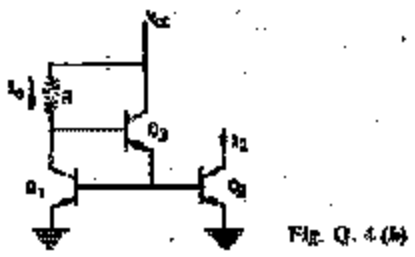

Fig. Q. 4 (b)

5. (a) The figure shows the common emitter small signal equivalent circuit of an amplifier. Determine the Z parameters for this two-port network. Is the network (i) acusal (ii) passive (iii) reciprocal?

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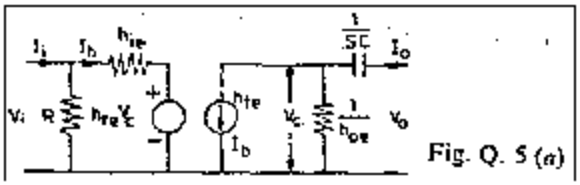

Fig. Q. 5 (a)

(b) Explain the principle of working of a strain gauge. What is gauge factor? Show how the strain gauge in be connected in bridges for measurement. A 350Ω nickel Chrome strain gauge(gauge factor 2) is working at 1000 micro-strain. What output voltage would be obtained if two such strain gauges are connected in a half bridge arrangement excited at 10V?

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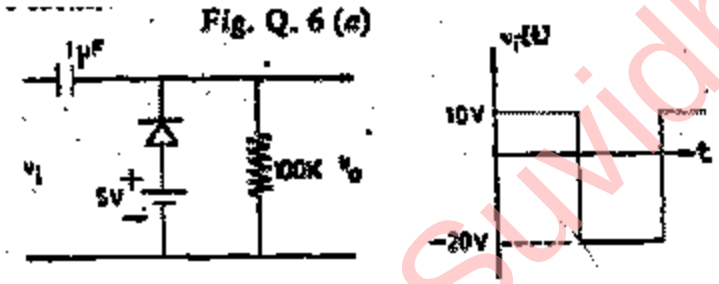
6. (a) The voltage shown has a frequency of 1 kHz and is applied to the diode circuit shown. Determine $v_0(t)$. Take diode as ideal.

Fig. Q. 6 (a)



(b) A step-graded germanium diode has a resistivity of 2 Ω-cm on the p side and 1 Ω-cm on the n side. Calculate the height of the potential barrier. For germanium μp= 1800 $cm^2/V\text{-}s$ and μn=3800 $cm^2/V\text{-}s$ and ni=$2.5\times10^{13}/cm^3$ at 300 K. Prove formula used.

7. (a) A CRO has an accelerating anode voltage of 5 kV and length of plates 4 cm. If the maximum error due to the time taken for the electrons to pass the plates is to be limited to 3%, what is the maximum frequency of sine waves that can be displayed ?

14

(b) A coaxial gable has an inner conductor of radius r and an outer sheath of inner radius b. A p.d of V volts is applied at one end between conductor an sheath and a direct current I flows through the conductor and returns through the sheath Find electric ad magnetic fields in the space between conductor End sheath end also calculate Poyting's vector in the following cases:

(i) When both inner conductor and sheath are perfect conductors.

(ii) When sheath is a perfect conductor but inner conductor is made of homogeneous conducting material with resistance R per metre Explain significance of Poyting's vector in either case.

8+12

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time allowed: 3 hours *Maximum marks : 200*

Candidates should attempt five questions choosing not more than three questions from each Section.

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

Answers must be written in English.

SECTION A

1. (a) The collector current in a bipolar npn transistor is expressed as

$$I_c = \alpha I_s \left(\exp \frac{q V_{BE}}{kT} - 1 \right)$$

where the symbols have their usual significance. Find the value of trans-conductance at a current of 1 mA at room temperature.

The drain current in a MOSFET may be written as

$$I_{DS} = k.\frac{W}{L}.\left[2(V_{GS} - V_T)V_O - V_{DS}\right]\left[1 + \frac{V_{DS}}{V_A}\right]$$

if $(V_{GS} - V_T) > V_{DS}$.

V_T is the threshold voltage. W=gate width, L = gate length and V_A is the early voltage. What are the parameters that, control the threshold voltage? At an operating point where $V_{GS} - V_T = 2V$, $V_{DS} = 1.0$ V and $V_A = 10$ V, the drain current is 0.33 mA. Find the trans-conductance and output conductance.

What will be the current equation if $(V_{GS} - Vr) < V_{DS}$?

Compare the input handling capabilities of bipolar and VET devices.

20

(b) Show bow the quiescent operating point of a CMOS inverter may be found graphically. Sketch the transfer characteristics (output voltage vs. input voltage and I_{DS} vs. input voltage) of the inverter.

An enhancement mode n channel MOS transistor has its drain connected to the gate. What will be the current-voltage relation of the device?

(c) Compare the performances of silicon bipolar and GaAs FET transistors as microwave (i) low noise and (ii) high power amplifiers.

8

2. (a) The schematic diagram of a CMOS differential amplifier consisting of a differential pair (Qn_1, Qn_2), a current source and load transistors (Qp_1, Qp_2), is shown In Fig. 1. Draw the equivalent circuit and derive an expression for the gain when the switch SW is connected to position a. Find the value of the low frequency differential gain given–

$$\left.\begin{array}{l}(i)\ gm_1 = gm_2 = 2m\ A/V \\ (ii)\ gd_1 = gd_2 = 0.2m\ A/V\end{array}\right\} n \text{ channel}$$

$$\left.\begin{array}{l}(iii)\, gm_2 = gm_4 = 0.5m\ A/V \\ (iv)\, gd_3 - gd_4 = 0.1m\ A/V\end{array}\right\} p-\text{channel}$$

What will be the change in gain if SW is connected to b?

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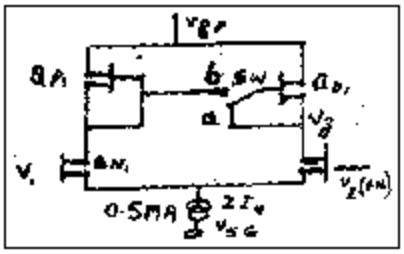

Fig. Schematic diagram of a CMOS OPAMP.

(b) The circuit of an emitter coupled free running multivibrator is shown in Fig. 2. Explain the operation of the circuit and sketch the waveforms at the emitters and collectors of Q_1 and Q2. How would you control the frequency ?

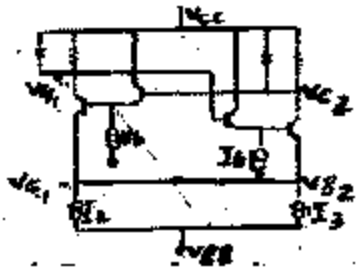

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Fig. 2 Circuit diagram of an emitter coupled VCO.

(c) Explain with circuit diagram the operation of a Schmitt trigger circuit. The output of a Schmitt circuit is applied to an integrator. If the output of the integrator is fed back to the Schmitt, what waveforms would one obtain?

8

(d) Show how an R–L–C filter can be realized using OP-AMP..

3. (a) Give the gate level schematic of a full adder and its MOS realization. Show how an array of full adders may be used to realize a 3 bit × 3 bit multiplier. If the propagation delay of a full adder is T_A, what will be the worst case delay in the multiplier? What is a serial parallel multiplier?

18

(b) Verify if the circuit of Fig. 3 represents a master slave JK F/F. How does one convert a JK F/F to a T F/F? Give the block schematic of a 4 bit counter.

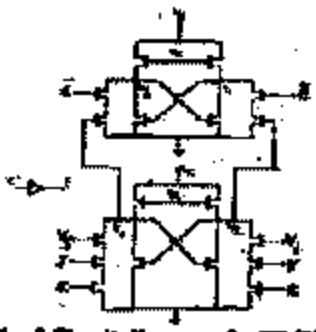

Fig. 3 Circuit diagram of a JK F/F

10

(c) Explain how an algorithm for binary division works.

6

(d) Given four enhancement mode n MOS transistors and one depletion mode a MOS transistors, demonstrate the realization of as many logic functions as possible.

6

4. (a) Show how a 3-bit decoder may be implemented using ECL. Give as example of emitter function logic.

8

(b) New 3 bit addresses are generated b computing the following logic functions:

$Z_n = CRS\ (Y_n)$.

$W_n = Zn\ \Delta\ B$,

and $Y_{n+1} = W_n$ XOR C,

where CRS signifies circular right shift. Assuming that Y_0=(0 0 1), C=(0 0 1), compute new addresses for the cases (i) B=(1 1 0) and (ii) B=(1 1 1).

12

(c) The following functions are to be realized using counters, accumulators. ALU and Muxes as principal components:

(i) (A+S) mod 7

(ii) IF X=0, THEN $Q_{n+1} = Q_n + 1$

ELSE $Q_{n+1} = Q_n$

(iii) IF X=0, THEN $Q_{n+1} = Q_n + 1$

ELSE $Q_{n+1} = F(Q_n)$

Give the circuit schematics for each case.

15

(d) Explain how the circuit of Fig. 4 enables READ and WRITE into Two bases.

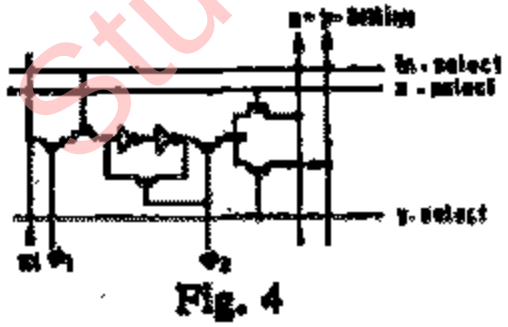

Fig. 4

5. (a) Describe the electrical and thermal characteristics of a thyristor. Explain the operation of a three-phase inverter using thyristors.

(b) Write a note on stepper motors. How are they controlled?

8

(c) A system has an open-loop transfer function given by

$$G(s)=\frac{K}{s\left(1+\frac{s}{10}\right)\left(1+\frac{s}{10}\right)}$$

Find the maximum value of K for which the system is stable under unity feedback conditions. Compute the velocity error co-efficient and phase margin at K = 10. Give the design of an equalizer to provide a velocity error coefficient of 100 and an adequate phase margin. Draw the Bode diagram of the system designed.

18

(d) List the non-linearities commonly encountered in control systems. Use the describing function method to find the equivalent linear gain of an ideal relay.

6

SECTION B

6. (a) Draw the circuit of a 3-bit parallel comparator analog to digital converter. Compare the speed. accuracy, and hardware requirement of flash ADC, successive approximation ADC and a delta-sigma coder.

12

(b) Discuss the operation of a multiplexing system suitable for a set of 1000 audio channels of 5 kHz bandwidth each and three TV channels of 4 MHz bandwidth each for transmission over a microwave network at 4 GHz.

8

(c) What are the modulation methods commonly employed in optical fibre communication network? Give reasons for their choice. A fibre optic system operating at a wavelength of 1.3 μm has the following system parameters:

Transmitter power = –3 dbm, Receiver sensitivity= –36 dbm, Connector loss = 2 db, Fibre loss=0.5 db/km, System margin=10 db.

Calculate the maximum link length. Draw the circuit or a trans-impedance amplifier.

14

(b) What Is a matched fitter? The symbols transmitted over a channel are : 1, 1, 1, –1, –1, 1, –1. What is the impulse response of the matched filter?

6

7. (a) Display the signalling waveforms of binary PSK, ASK, DPSK and FSK. Compare the error probability performance of the above keying systems. How would an system behave in the presence of fading? How does one combat fading?

12

(b) Use the identity

$x^7+1 = (x^3+x+1)(x^3+x^2+1)(x+1)$ mod 2 to implement a shift register network for a (7, 3) code. How would you detect an error ?

8

(c) Describe the operation of a modulator and demodulator for FM that may be used for both analog and. keyed systems. Write a note on SNR improvement and threshold behaviour in FM.

12

(d) A pulsed sinusoid of duration T sec at an-angular frequency of ω_0 is applied to an ideal band-pass filter tunned to ω_1. Show how the envelope of the output of the filter would vary with time if

(i) $\omega_0 = \omega_1$,

(ii) $\omega_0 = \omega_1 + \frac{\pi}{T}$ and

(iii) $\omega_0 = \omega_1 \frac{2\pi}{T}$.

8

8. (a) Derive the expressions for the reflection and transmission coefficients for a uniform plane wave incident on the boundary surface between two dielectric media.

8

(b) Discuss how the effective dielectric constant of an ionized medium would vary with the frequency of the Incident signal.

8

(c) A transmission line of characteristic impedance 50 ohms is terminated by an impedance of 100 ohms. Find the value of the standing wave, ratio and the distance where the input conductance is 20 milli mho. Express the distance as a fraction of wavelength.

8

(d) A rectangular waveguide has cross-sectional dimensions of 3 cm x 1.5 cm. Calculate the wavelength corresponding to the first mode (TE_{10}) of an air-filled metal guide. Sketch the field distribution for the dominant mode.

8

(e) Write a note on microwave filters using transmission line component.

8

9. (a) Describe briefly with block schematic diagrams the operation of a colour TV transmission system. State the distinctive features of a TV receiving antenna.

12

(b) Derive the radar range equation.. Discuss the considerations for selecting

(i) the frequency of operation

(ii) antenna pattern and

(iii) scanning methods for ground and airborne radars.

12

(c) Give the block schematic diagram of a low power (<50 W) radar at 6 GHz using solid state active components.

8

(d) Explain how 'delay lines' may be used to provide

(i) pulse to pulse video integration and

(ii) background cancellation.

8

10. Write short notes on any four of the following: 40

(a) Digital Television.

(b) Computer Communication.

(c) Magnetic Memories.

(d) Ferrite Microwave Devices.

(e) Biomedical Electronics.

(f) Time and Frequency Standard.

(g) Satellite Communication.

(h) Digital Signal Processing