ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time allowed: 3 hours *Maximum marks: 200*

*Candidates should attempt Question 1 which is compulsory and any **four** of the remaining question.*

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

Answer must be written in English.

1. Answer briefly and to the point:

8×8=64

(a) Can an inductor of value 1 mH be fabricated by the integrated circuit technology? If your answer is 'yes', explain how. If your answer is 'no', suggest an alternative.

(b) Draw the symbol of a TRIAC and its principal v–i characteristics. Label each diagram in as much detail as possible.

(c) When two 2-port networks are connected in parallel, the [y] matrix of the resulting network may not be the sum of the [y] matrices of the component networks. Why? Give examples to illustrate this fact.

(d) A source of internal impedance R_s + jX, delivers power to a variable load of impedance R_L + j0. Derive the condition(s) for maximum rowel in the load.

(e) In an a c. circuit the effective resistance of a conductor is higher than its d.c. resistance. Why is this so ?

(f) Define the term 'radiation resistance' as applied to an antenna. Consider two dipoles of lengths *l* and 2*l* which are excited by sinusoidal currents at frequencies f and f/2 respectively. What is the ratio of their radiation resistances ?

(g) Explain how a Q-meter can be used to measure the primary constants R, L, G, C of a transmission line.

(h) What is an instrumentation amplifier ? Draw the circuit of such an amplifier using op. amps. and derive an expression for its gain.

2. (a) Derive the diffusion equation

$$\frac{\partial N}{\partial t} = D\frac{\partial^2 N}{\partial z^2}$$

where the symbols have their usual meanings.

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(b) Sketch five different connections in which a bipolar junction transistor can be used as a diode. Determine the series resistance in each case, if the given transistor can be represented by the equivalent circuit shown in Fig. Q. 2 (b). Which of these five connections has the lowest series resistance?

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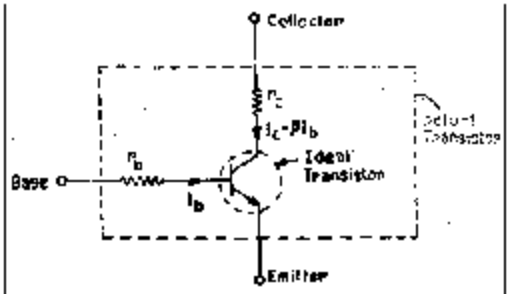

Fig. Q. 2 (b)

3. (a) The circuit shown in Fig. 3 (a) is known as a

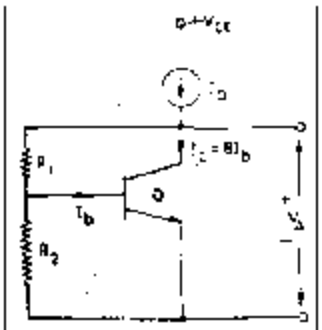

Fig. Q. 3 (a)

V_{BE} multiplier. Justify this by deriving an expression for V_A. Draw a sketch of V_A versus IO. Identify clearly the regions in which Q is ON and Q is OFF.

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(b) The electric field

$$\vec{E} = 2\cos\left(10^8 t - z\right)\vec{a}_x + 2\sin\left(10^8 t - z\right)\vec{a}_y$$

where $\vec{a}_x$ and $\vec{a}_y$ are unit vectors in the z and y directions, is established in a certain material, whose permeability is the same as that of free space. What is the permittivity of the medium relative to free space? Determine the accompanying magnetic field $\vec{H}$.

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4. (a) Realize the driving point admittance

$$Y(s) = \frac{3s^2 + 10s + 6}{s^2 + 6s + 6}$$

in the form shown in Fig. Q. 4 (a).

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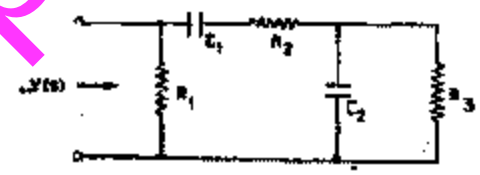

Fig. Q. 4 (a)

(b) Find another realization, of Y(s) of Q. 4 (a), which is different from Fig. Q. 4 (a).

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(c) In the circuit of Fig. 4 (c), Q_1 and Q_2 are identical. Find I_2 in the terms of I_0.

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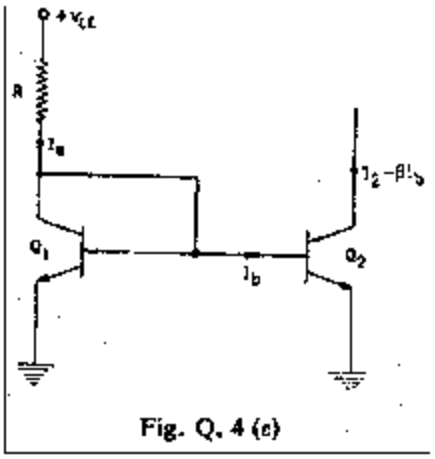

Fig. Q. 4 (c)

5. (a) For the circuit shown in Fig. 5 (a), obtain an expression for the current I_x in terms of I_s and the circuit parameters. Find the condition(s) under which $I_x = 0$.

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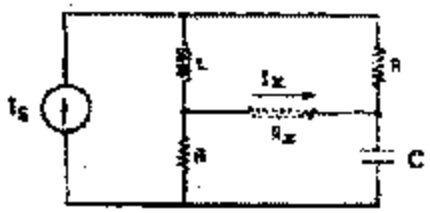

Fig. Q. 5 (a)

(b) Probe measurements on a uniform plane wave show that the electric field $\vec{E}$ has only a z-component and that the distance between the positive maxima, as measured along the x and y axes, are 5 m and 3 m respectively. Specify the direction of propagation by a unit vector. Also, find the wavelength.

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6. (a) The bridge shown in Fig. Q.6(a) can be used for measuring an unknown inductance L_x and its series resistance

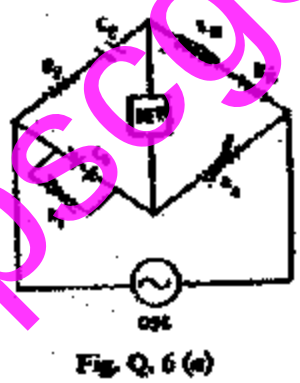

Fig. Q. 6 (a)

Rx. Determine the conditions for resistive and reactive balance. Are they independent of each other ? What are the largest values of L_x and R_x which can be measured by the bridge if: R_1=20 kΩ (fixed); R_2=50 kΩ; C_2 = 0.003 μF; Source frequency = 1 megaradian/s; c_1 is adjustable from 10 pF to 150 pF; and R_4 is adjustable from 0 to 10kΩ?

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(b) A two-wire lossless line in air, having a characteristic impedance of 100 R and a phase shift of ½rad/m, is terminated in a 100 pF capacitor in parallel with a 100 Ω. resistor. Determine the VSWR on the line.

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7. (a) A capacitive transducer, used to measure small displacements, consists of the interdigital arrangement of nine plates in air, as shown in Fig. 7 (a). Each plate measures 25 mm × 25 mm and the distance between two consecutive plates is 0.25 mm. Determine the sensitivity of the device. (Assume. the permittivity of air to be 8.85 pF/m.)

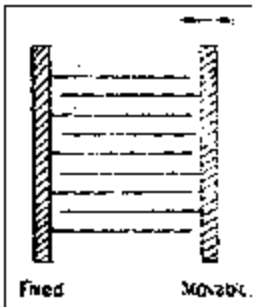

Fig. Q. 7 (a)

(b) It is desired to measure the peak value of a 100 kHz sinusoidal voltage source of output resistance 10 kΩ with a CPO whose input resistance is 1 MΩ and whose input capacitance is 50 pF. Determine the percentage error of this measurement.

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(c) A temperature sensing device can be modelled by a first order system with a time constant of 6 seconds. If at t=0, the temperature is suddenly increased from 25°C to 150°C, what temperature will be indicated after 10 seconds?

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time allowed : 3 hours *Maximum marks: 200*

Candidates should attempt five questions, choosing not 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 current-voltage characteristic of an n-channel MOSFET is given by

$I_D = K(2(V_{GS}-V_T)V_{DS}-V^2_{DS})$, if $V_{GS}-V_T > V_{DS}$

$= K(V_{GS}-V_T)^2$, if $V_{GS}-V_T < V_{DS}$

The MOSFET is operated as a self-biased amplifier with a drain load of 100 k ohms. Given that the supply voltage is 5 V, K=20 microamp/V^2, VT=–2 volts, self-bias voltage across a source resistance of 50 k ohm is 1V, find the gain of the amplifier. Ignore the impedance of the bypass capacitor across the source resistance.

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(b) Can we use three or more transistors to form Darlington pairs? Justify your answer.

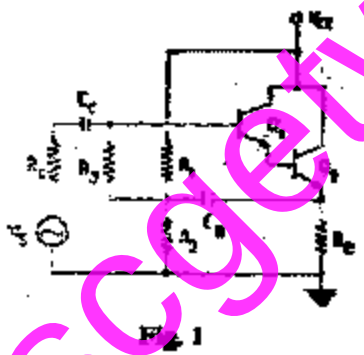

Fig. 1

Explain the principle of operation of the Darlington emitter follower employing modified bias circuit shown in Fig. 1. If the gain of this amplifier be 0.99, determine the value of R_3 for obtaining effective input resistance contributed by R_3 greater than 10MΩ.

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(c) What type of feedback circuit is represented by the circuit shown in Fig. 2? Draw the equivalent circuits of this amplifier and hence obtain the input impedance with feedback.

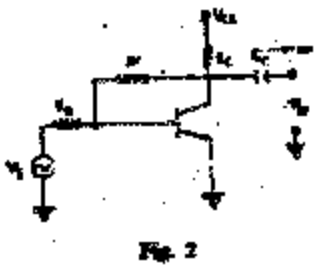

Fig. 2

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2. (a) How is an operational amplifier used as a buffer stage ? Derive expressions for the input impedance and gain of such a buffer stage.

12

(b) An unregulated supply varies between 20 and 25 volts and has a 10Ω internal resistance. A 10 V Zener diode with maximum dissipating power of 800 mW is to regulate this voltage for use in a tape recorder. The recorder draws 30 mA while recording and 50 mA while playing back. The 'Knee' of the Zener characteristics occurs at 10 mA. The Zener diode resistance may be assumed to be 10Ω in the operating range. Determine the series resistance needed so that the Zener diode regulates continuously.

16

(c) A voltage pulse of width t_p is applied to a high- pass RC circuit. Plot the output waveform for

(i) $\frac{RC}{t_v} >> 1$

(ii) $\frac{RC}{t_v} << 1$ and explain .

12

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

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(b) The circuit of the emitter coupled astable multivibrator is shown in Fig. 3. Explain its operation as a voltage controlled oscillator and sketch the waveforms at various points.

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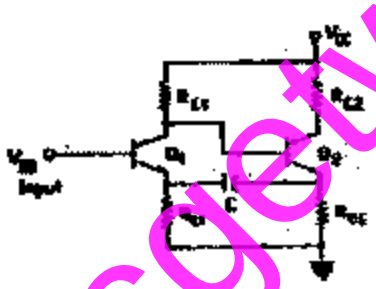

Fig. 3

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

14

4. (a) Use a Karnaugh map to simplify the Boolean expression

$$Y = ABC + A\bar{B}\bar{C} + AB\bar{C} + A\bar{B}C + \bar{A}BC$$

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(b) Explain the operation of the circuit shown in Fig. 4 and show the waveforms at nodes a and b.

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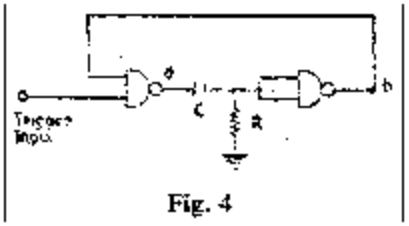

Fig. 4

(c) Sketch a 4 bit shift left register and explain its performance.

10

(d) Write the truth table for a full subtractor and hence obtain its logic circuit.

10

5. (a) Develop a state equation formulation for a System described by

$$\ddot{x} + a_1\dot{x} + x = y$$

and give an analog simulation diagram. Sketch the phase plane trajectory for a_1=12 and derive the step response from the diagram. Indicate the modification in the trajectory when a_1 is replaced by a non-linear function of x.

14

(b) Draw a signal flow graph for the system shown in Fig. 5 and hence obtain the transfer function C(s)/R(s) using Mason's gain formula.

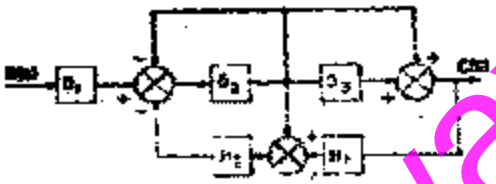

Fig. 5

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(c) A closed loop control system is to be designed for an under damped response to a unit step. Find the desirable range of pole locations for the second order system. The specifications for the system are:

30% > per cent overshoot > 10%

Setting time < 0.4 sec for ±2% tolerance band.

12

SECTION B

6. (a) Show the time domain and frequency domain (spectrum) characteristics of the following modulated waves produced by a single tone:

(i) AMSC wave

(ii) SSB upper side band.

5

(b) With the help of suitable analytical steps show that for AM with large noise the performance of the envelope detector proves inferior to the rpnchronous detector.

10

(c) Without taking recourse to derivation of expressions for SNR discuss the threshold effect in FM and its improvement with phase locked loop.

10

(d) Briefly describe a scheme for the implementation of a DPCM system. Discuss advantages and disadvantages of DPCM compared with PCM.

15

7. (a) Draw a properly labelled block diagram of a monochrome TV transmitter.

12

(b) Discuss the operation of the colour demodulators in a TV receiver. Explain why (R–Y) and (B–Y) are normally selected as their outputs.

12

(c) Explain the working of a pulsed radar system. Compare its merits and demerits with CW Doppler radar system.

16

8. (a) An MTI radar operates at 10 GHz with a PRF of 3000 pp. Calculate the lowest three blind speeds of this

6

(b) Write main features of Start-Stop telegraphy used in tele-printers.

8

(c) Describe the construction and characteristics of the microphone employed in telephone handset.

12

(d) An analog signal is band limited to B Hz, sampled at the Nyquist rate and the samples are quantized into 4 levels. The quantized levels are assumed independent and occur with probabilities 1/4, 1/3, 1/8 and 1/2. Find the average information and information rate of the source.

14

9. Obtain an expression for the velocity of propagation (group velocity) in a waveguide.

A 6 GHz signal is to be propagated in the dominant mode in a rectangular waveguide. If its group velocity is to be the 90% of the free space velocity of tight, what must be the breadth of the waveguide? What impedance will it offer to this signal, if it is correctly matched ?

14

(b) Briefly describe the cavity coupling methods. Find the resonant frequency of a copper rectangular cavity of dimensions a=b=d=10 cm for TE_{101} mode.

12

(c) What is the principle of strapping in a magnetron? What are he disadvantages of strapping under certain conditions? Show the cross section of a magnetron anode. Cavity system dial does not require strapping.

14

10. Write notes on any four:

14

(a) Satellite communication

(b) CMOS

(c) Integrated injection logic

(d) DAC

(e) IMPATI

(i) Electronic switching system

(g) Optical fibres

(h) Semi-conductor laser.