

# ELECTRONICS AND TELECOMMUNICATION ENGINEERING

## PAPER - I

Time allowed: 3 hour

Maximum marks: 200

Candidates should attempt Question 1 which is compulsory 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) Draw the equivalent circuit of a practical resistor, taking its lead inductance and stray capacitance into account. Show that, at low frequencies, the practical resistor may behave as an ideal resistor if the element values are properly related. Find this relation. 8
- (b) Draw the equivalent circuit of a practical capacitor, taking its lead inductance, lead resistance and leakage resistance into account. What is the frequency above which the capacitor actually behaves as an inductor? 8
- (c) The impedances of the two networks shown in Fig. 1 are the same. Find the values of  $C_1$ ,  $B_2$ ,  $R_2$  and  $O_2$ . 8

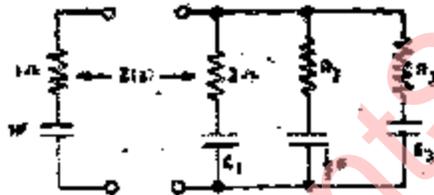


Fig. 1

- (d) State and prove the initial value theorem of Laplace transforms. 8
- (e) Find the intrinsic carrier concentration of Germanium, if its intrinsic resistivity at 300 °K is 0.47 ohm-m. It is given that the electronic charge is  $1.6 \times 10^{-19}$  coulombs, and that electron and hole mobilities at 300 °K are 0.39 and 0.19  $m^2/(volt \cdot sec)$ . 8
- (f) An antenna array is required to produce the normalized radiation pattern shown in Fig. 2. Specify all that you can about the array. 8

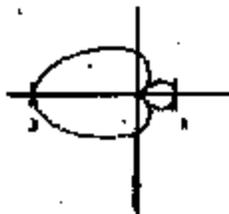


Fig. 2

(g) A voltmeter having a sensitivity of  $1000 \Omega/V$  reads 100 V on its 150 V scale when connected across an unknown resistor  $R_x$  in series with a milliammeter which reads 5 mA. Find  $R_x$ .

8

(h) What is the resolution of a  $3\frac{1}{2}$  digit display DVM for 0 to 1 V range? What is the resolution on the 0 to 10 V range?

4

2. (a) Give a schematic diagram of the SCR and derive its equivalent representation in terms of transistors. Express the current in the SCR in terms of the  $I_{co}$ 's and alphas of the individual transistors.

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(b) The diode shown in Fig. 3 is not ideal, and has a reverse saturation current of  $10 \mu A$ . Find the peak forward current in the diode and the peak forward voltage drop across it.

13

(c) Draw the complete hybrid- $\pi$  equivalent circuit of a transistor and find an expression for the short-circuit current gain.

10

3. (a) Explain, with a neat block diagram, the principle of operation of an instrument for measurement of the harmonic content of a waveform, using a null network.

10

(b) A coil was tested using a Q-meter and the following results were obtained:

Oscillator Frequency	Tuning Capacitance Setting
3 MHz	251 pF
6 MHz	50 pF

Find the self-capacitance of the coil.

12

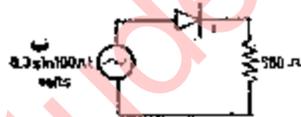


Fig. 3

(c) A strain gauge of resistance  $1k\Omega$  and gauge factor 2 is mounted on a cantilever beam and connected in one arm of a Wheatstone bridge, whose other three arms have a resistance of  $1k\Omega$  each. The bridge is supplied by a 10V source and the detector has a resistance of  $1k\Omega$  and a sensitivity of  $10 \text{ mm}/\mu A$ . What is the detector deflection for 0.1% strain?

13

4. (a) Explain how Hall effect can be used to the carrier concentration in a semi-conductor.

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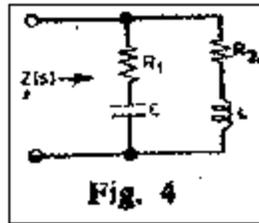
(b) Synthesize a network to realize the voltage transfer function

$$\frac{V_0(s)}{V_i(s)} = K \frac{s+a}{s+b}$$

where  $a < b$ . What is the highest possible value of K that can be realized?

13

- (e) Determine the relationship(s) between the elements of the network of Fig. 4 so that its Impedance is resistive at all frequencies.



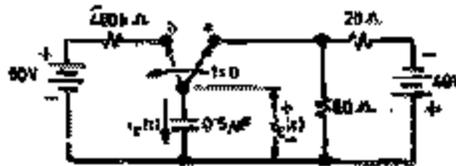
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5. (a) The switch in the circuit shown in Fig. 5 has been in position a for a long time. At  $t=0$ , the switch is moved to position b. Find  $v_c(0^+)$ ,  $v_o(0^-)$

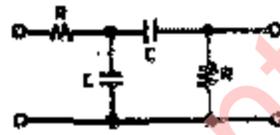
$\left. \frac{dv_o(t)}{dt} \right|_{t=0^+}$ ,  $v_o(t)$  for  $t>0$  and  $i_c(t)$  for  $t>0$ . At what value of  $t$  will  $v_c(t)$  pass through zero value?

18

- (b) Find the transfer function of the network shown in Fig. 6. Plot the magnitude response of the network and show that it behaves a band-pass filter. What are its centre frequency and Q?



**Fig. 5**



**Fig. 6**

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6. (a) Calculate, from first principles, the capacitance of a spherical condenser, formed by two concentric conducting spherical shells of radii  $a$  and  $b$ ,  $b>a$ , when the region between the spheres is a dielectric with permittivity  $\epsilon$ .

15

- (b) Carry out appropriate mathematical analysis to derive a physical interpretation of the quantity  $\vec{E} \times \vec{H}$  for a uniform plane electromagnetic wave.

20

7. (a) A two wire lossless transmission line of characteristic impedance  $300\Omega$ , length  $2\text{m}$  and velocity of propagation  $2.8 \times 10^8 \text{ m/s}$  is driven by a sinusoidal source of  $300\Omega$  internal resistance,  $60\text{V}$  amplitude and  $100 \text{ MHz}$  frequency, and is terminated in a resistance of  $150\Omega$ . Determine –

- (i) the reflection coefficient at the output end
- (ii) the VSWR on the line
- (iii) input impedance
- (iv) input current
- (v) average power supplied to the line

- (vi) average power supplied to the load
- (vii) the amplitude of the load voltage.

20

- (b) A pure sine wave at a frequency of  $\omega_0$  rad/s is required for a particular application. The available signal generator produces a waveform at  $\omega_0$  rad/s, which is rich in the second and third harmonics. Give a simple means of getting rid of these harmonics using the LEAST possible number of circuit elements. Give the element values in terms of  $\omega_0$ .

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# 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) Discuss the different types of transistor biasing circuits. Derive an expression for the stability factor in self-biasing circuit. 12
- (b) In an R-C coupled amplifier using transistors, find the mid-band gain and the two half-power frequencies neglecting the effect of biasing components in the circuit. The device parameters are  
 $h_{ie}=2\text{ k}\Omega$  ;  $h_{fe}=50$ ;  $C_{bje}=100\text{ pF}$ ;  $C_{bje}=4\text{ pF}$ ;  $R_c = R_L = 10\text{ k}\Omega$ ;  $R_s = 1\text{ k}\Omega$ ;  $C_e = C_b = 1\mu\text{F}$ ;  
 $C_E=20\mu\text{F}$ ;  $R_E = 1\text{ k}\Omega$ . 14
- (c) In the circuit shown in Fig. 1,  $R_d=12\text{ k}\Omega$ ,  $R_g=1\text{ M}\Omega$ ;  $R_s=2\text{ k}\Omega$ ;  $V_{DD}=25\text{ volts}$ ;  $C_s=100\mu\text{F}$ ;  
 $I_{DSS}=4\text{ mA}$ ;  $V_P=-4\text{ volts}$ ;  $g_m=1\text{ m}\Omega$ ;  $r_d \geq R_d$ .  
 Determine  $V_{DS}$ ;  $I_d$ ;  $V_{gs}$  and  $AV$ .



- 14
2. (a) Draw the equivalent circuit of a CE amplifier using hybrid  $\pi$  model at high frequencies and derive the expression for voltage gain and band-width taking source resistance into account. 10
- (b) A silicon transistor has the following parameters:  
 $h_{fe}=50$ ;  $h_{ie}=1\text{ k}\Omega$ ;  $f_T=300\text{ MHz}$ ;  $C_{bje}=4\text{ pF}$ ;  $I_c=2.0\text{ mA}$ ;  $T=25^\circ\text{C}$ .  
 Calculate  $g_m$ ;  $r_{b'e}$ ;  $r_{bb}$ , and  $C_{bje}$ . 10
- (c) Design a series voltage regulator to give an out put voltage of 20 volts d.c. and a load current of 500 mA. Provide current limiting circuit and preregulator. The Unregulated supply has  $V_i=50\pm 5\text{ volts}$ . 10
- (d) Draw the circuit of a cascode amplifier using BJT and FET. Explain its working.



## SECTION B

6. (a) Explain the process of 'drift space bunching' and reflector bunching' using Applegate diagrams. 7
- (b) Prove that the electronic admittance in a Reflex Klystron is a soiral. 15
- (c) Design a rectangular waveguide with copper conductor and air dielectric so that the dominant mode will propagate with 30% safety factor ( $f=1.3 f_c$ ) but also so that the wave type with next higher mode cutoff is 30% below its cutoff frequency. Assume  $f=3.0$  GHz. 10
- (d) To identical 20 db directional couplers are connected back to back in a microwave reflectometer measurement setup. The reading on the power-meter in the forward direction was 1.0 mW and in the reverse direction was 0.1 mW. Calculate the reflection coefficient and VSWR on she line. 8
7. (a) Explain the principle and Working of a GUNN oscillator. 12
- (b) Determine the resonant frequency of a cube of side 1.0 cm in  $TE_{111}$  mode. 8
- (c) Explain the importance of scattering parameters in microwave measurements and write the scattering matrix for a 3-port ideal circulator and a 3-db 3-port power divider. 10
- (d) Draw the block diagram of a Microwave Link Repeater and explain its working. 10
8. (a) Describe the different tones used in an auto-telephone exchange. 6
- (b) Why are TV standards required? Compare the US and Indian TV standards (monochrome) giving at least 10 selected parameters. 7
- (c) Using a circuit diagram explain how sync. pulses are obtained from the composite video signal and how in turn horizontal sync. pulses are extracted. 15
- (d) State Hartley-Shanon theorem and explain.  
A system has a bandwidth of 4.0 kHz and an  $S/N$  ratio of 28 db at the input to the receiver, calculate (i) its information carrying capacity and (ii) the capacity of the channel if its bandwidth is doubled while the transmitted signal power remains constant. 12
9. (a) Explain the working of an MTI Radar system with the help of a block diagram. 15

- (b) Calculate the maximum range of a guided Missile Tracking Radar operating at 5.0 GHz with a 1.0 MW peak power output. The antenna diameter is 3.66 m and the receiver has a bandwidth of 16 MHz with 11.0 db noise figure. The target cross-section is  $1.0 \text{ m}^2$ .
- (c) Explain the terms unselector, group selector and final selector. Give the Trunking diagram of a 1000 line auto exchange and explain.

15

10. Write short notes on any four:

- (a) PCM and its advantages. (b) Magnetron. (c) Colour TV (d) Companding (e) Lag-lead compensation networks. (f) Phase locked loop. (g) A/D converters. (h) Full adder circuit.

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