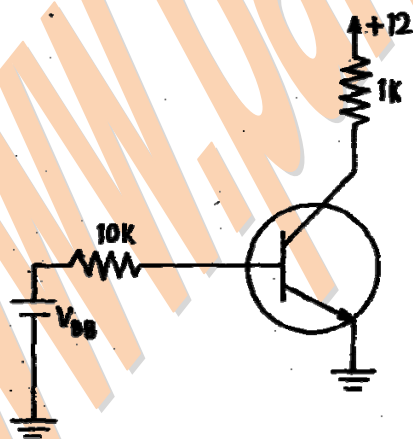


## ELECTRONICS AND TELECOMMUNICATION ENGINEERING

## PAPER - I

1. (a) Name three acceptor and three donor materials for doping of a semiconductor, Draw, roughly to scale, neat and labelled energy band diagrams for a metal, an n-type semiconductor and an insulator, at room temperature.
- (b) Define the terms  $f_\alpha$ ,  $f_\beta$  and  $f_T$  as applied to a transistor and establish the relations between them.
- (c) Define the term  $Q$ , as applied to a coil, in terms of energy, and use the same to derive an expression for the  $Q$  of a coil which can be represented as a parallel RL combination, at a frequency  $f$ .
- (d) Sketch the functions  $tu(t)$ ,  $(t-T)u(t)$ ,  $tu(t-T)$  and  $(t-T)u(t-T)$  where  $u(t)$  is the unit step function, and write down their Laplace transforms.
- (e) An inductance is fabricated by winding  $N$  turns of wire around a circular iron core of cross-sectional area  $A$ , permeability  $\mu$  and mean length  $l$ . It carries a current  $I$ . What do you mean by term 'mean length'? Write expressions for the m.m.f, the reluctance of the coil, the flux linked with each turn of the coil, and the inductance of the coil.
- (f) From a lot of 5 mF, 200V capacitors, how would you construct a 10  $\mu$ F, 1,000 V capacitor using the minimum number of 5  $\mu$ F capacitors?
- (g) Explain how the low frequency 3 db point of an-amplifier can be measured by square wave testing.
- (h) Explain, with a block diagram, how the average speed of an object can be measured by using two photo cells with associated electronic circuits so that the indication is digital.
2. (a) What do you mean by 'saturation' of a transistor? In the circuit shown in Fig. Q 2a, determine  $V_{BB}$  to saturate the transistor. Assume  $V_{CEsat} = 0.1$  V,  $V_{E,sat} = 0.6$  V and  $h_{FE} = 50$ .



- (b) State and prove Miller's theorem. Apply it to unilateralize the hybrid equivalent circuit of a common emitter amplifier with a resistive load. State clearly the assumptions involved.
3. (a) Synthesize one RL and one RC network to realize the open circle voltage transfer function

as-b

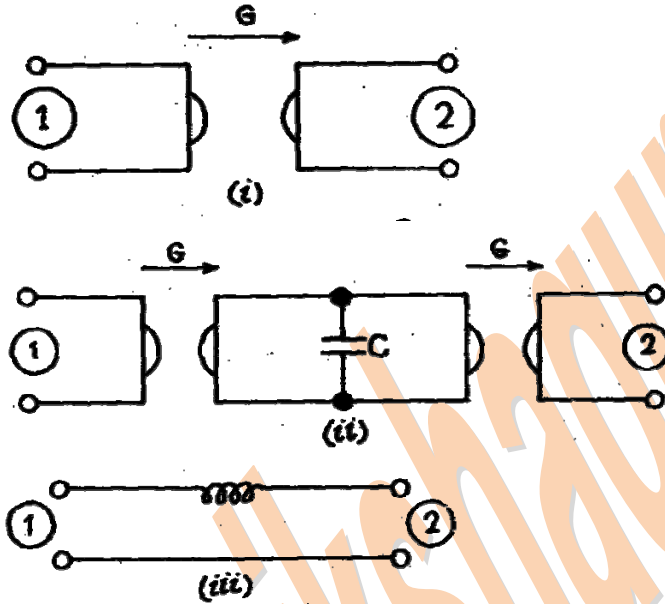
as+b

Justify your answers fully.

- (b) Fig Q.3 bi shows a two-port device called the gyrator whose short-circuit admittance matrix is

$$[y] = \begin{bmatrix} 0 & -G \\ G & 0 \end{bmatrix}$$

Show that the two two-ports of Fig. 3 Q. 3 bii and Q 3 biii are equivalent. Find L.



4. (a) An air-filled coaxial cable has inner and outer conductors of radii  $a$  and  $b$ . The primary constants of the line, per unit length, are given by

$$C = 2\pi\epsilon_0 / \ln \frac{b}{a} \quad R = \frac{1}{2\pi\sigma\delta} \left( \frac{1}{a} + \frac{1}{b} \right)$$

$$L = \frac{\mu_0}{2\pi} \ln \frac{b}{a} \quad G = 0$$

What do  $\alpha$  and  $\delta$  in the expression for  $R$  stand for? It is known that at the frequency of operation  $f$ ,  $2\pi fL \gg R$ . Find approximate expressions for the characteristic impedance  $Z_0$  and the attenuation per unit length of the line. Show that the latter is a minimum when

$$\frac{b}{a} \ln \frac{b}{a} = 1 + \frac{b}{a}$$

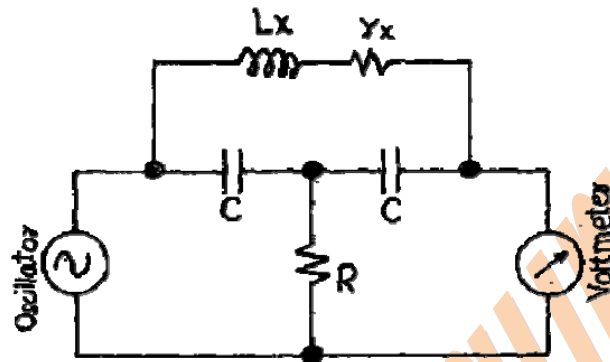
- (b) Let a lossless transmission line of length  $l$  and characteristic impedance  $Z_0$  be terminated in a load impedance  $Z_L$ . Let distances be measured from the load and i.e. let  $x=0$  correspond to the load end and  $x=l$  correspond to the source end. Also, let  $V_1$  denote the amplitude of the incident wave at the source end. Show, from first principles, that the total voltage  $V$  at any point  $x$  of the line is given by

$$V = \frac{2V_1 e^{-j\beta l}}{Z_L + Z_0} (Z_L \cos \beta x + jZ_0 \sin \beta x)$$

where  $\beta$  is the phase constant of the line.

5. (a) Explain, with a block diagram, how A/D conversion can be achieved by using an analog comparator, a counter, a D/A converter and an appropriate gate circuit.

- (b) Show that the inductance  $L_x$  and its equivalent series resistance  $r_x$  can be measured with the circuit shown in Fig. Q.5b. Indicate, clearly, the following:
- In the measurement, should the voltmeter reading be maximised or minimized?
  - What is (are) to be varied to achieve (i): oscillator frequency,  $C$ ,  $R$  or a combination of them?
  - If more than one parameter is to be varied in (ii) what is the sequence of variation?



6. (a) A parallel plate capacitor has plates of surface area  $0.01 \text{ m}^2$ , which are separated by a distance of  $0.005 \text{ m}$  in air. Calculate the capacitance, given that permittivity of air is  $8.9 \times 10^{-12} \text{ F/m}$ .

A slab of pyrex glass of dielectric constant 5.6, which just fills the space between the plates, is slid between them. Determine the change in capacitance.

Let the capacitor with air dielectric be charged to  $100 \text{ V}$  and disconnected from the charging source. Now, if the pyrex glass is inserted between the plates, how does the voltage change? What is the percentage change in the stored energy?

- (b) Let  $Z(s)$  be an RC impedance, where  $s = \alpha + j\omega$  is the complex frequency. Draw sketches of possible variation of  $Z(\alpha)$  with  $\alpha$ .

From amongst the four impedance functions given below, pick up the one which qualifies as RC, and give its Foster I and caner II realizations.

$$\frac{s(s+2)}{(s+1)(s+3)}, \frac{s(s+1)}{(s+2)(s+3)}, \frac{(s+1)(s+3)}{s(s+2)}, \frac{(s+2)(s+3)}{s(s+1)}.$$

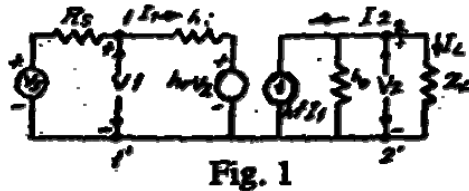
7. (a) Consider a linear, centre-fed, dipole antenna of half length  $l$  radiating a wave of wavelength  $\lambda$ . Sketch the current distribution in the dipole and its radiation pattern for each of the following cases:
- $l/\lambda \leq 0.05$
  - $l/\lambda = 0.25$
  - $l/\lambda = 0.5$
  - $l/\lambda = 2/3$
  - $l/\lambda = 3/4$
- (b) Explain with necessary block diagrams and equations, how the following performance characteristics of a medium wave AM transmitter can be measured:
- percentage modulation
  - power output.

## ELECTRONICS AND TELECOMMUNICATION ENGINEERING

## PAPER - II

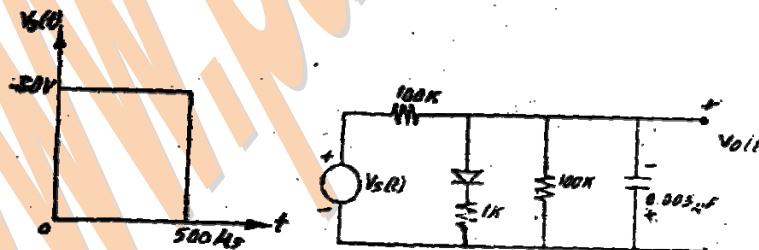
## SECTION A

1. (a) The h-parameter model of a transistor amplifier connected as a common-emitter amplifier for low frequency small signal operation is shown in Fig. below:



Derive expressions for voltage gain, current gain, input impedance. Output admittance and power gain. Find the above quantities for the above circuit. Given:  $h_{11} = h_i = 100 \text{ ohms}$ ;  $h_{12} = h_x = 2.5 \times 10^{-4}$ ;  $h_{21} h_f = 50$ ;  $h_{22} = h_o = 25 \text{ microamps/volt}$ ;  $R_s = 1000 \text{ ohms}$ ;  $Z_L = 1600 \text{ ohms}$  (resistive).

- (b) Discuss qualitatively the various arrangements used for bias stability and their effectiveness and otherwise.
- (c) Develop an expression for the stability factor for a collector to base bias arrangement. Also explain how the collector to base bias circuit will stabilise the operating point for variations of  $\beta$ .
2. (a) Derive an expression for output voltage for a low-pass R-C filter when an input pulse is applied. Obtain an expression for rise time in terms of 3-db cut-off-frequency.
- (b) If the R-C time constant of a high-pass circuit is made increasingly smaller in comparison to the duration of the input waveform, is the width of the output pulse increased or decreased? Give analytical reasons for your answer.
- (c) A single pulse shown in Fig. 2(a) is applied to the circuit Fig. 2(b) at  $t=0$ . If the initial voltage on the capacitor C is  $-20 \text{ volts}$ , with polarity shown in Fig. 2(b), evaluate the complete output response. Make reasonable approximations and state them clearly.



**Fig. (a) Fig. 2(b)**

3. (a) Explain the principle of operation of a Forward Switching Regulator and obtain the expressions for inductance and capacitance used in the regulator. Choose L and C in such a way that the peak variation of current through L do not exceed 20% of average value of current through it.

- (b) A series dissipative regulator has an output voltage of 30 volts at a rated load current of 10 amps. If the stand-by current be 500 milliamps, calculate the efficiency of the regulator when the input voltage is (i) 33 volts (ii) 43 volts.
4. (a) Develop the Boolean equations for 2 input and 3 input NOR gates giving suitable symbols and tables.
- (b) Explain De Morgan's first theorem using circuits of NOR gate as well as AND gate with inverted inputs. Give the relevant tables.
- Using NAND gate and OR gate with inverted inputs, explain De Morgan's second theorem.
- (c) Discuss in details, the working of full-adder logic circuit and extend your discussion to explain a binary adder that can be used to add two binary numbers.
5. (a) State and explain Nyquist stability criterion in feedback control system, taking a specific example and giving relevant sketches.
- (b) Explain Hurwitz stability criterion for determining stability.
- The characteristic equation of a fourth order system is
- $$s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$$
- Find the stability of this system.
- (c) Take an R-C filter network and develop a polar plot of its sinusoidal transfer function to show that it is a semicircle.

## SECTION B

6. (a) Explain giving Applegate diagrams, the principle of velocity modulation used in Double-resonator Klystrons as well as Reflex Klystrons.
- (b) Give a complete analysis to obtain the relationship between accelerating and reflector voltage required for oscillations in a Reflex Klystron, stating clearly the assumptions made. Hence explain how only discrete values of reflector voltage can produce oscillations.
- (c) Describe clearly, giving relevant sketches, how Magnetrons can be tuned. Also state the extent in percentage to which the frequency can be varied.
7. (a) Starting with Maxwell's field equations and wave equations, develop expressions for the various electric and magnetic field intensity components for a TE mode of propagation in a perfectly conducting hollow rectangular waveguide. Assume that the guide has a width  $a$  in the  $x$ -direction, and height  $b$  in the  $y$ -direction, with energy propagating in the  $z$ -direction.
- (b) Hence obtain expressions for field intensity components for the dominant TE mode and also expressions for the phase constant, cut-off frequency, velocity of propagation and guide wavelength.
8. Write detailed notes, but to the point, on the following:
- (a) Magic Tee
- (b) Directional couplers along with the mode of propagation
- (c) Bolometer Bridge
- (d) Metallic lens and the shape of profile of metal strips used in lens for microwave working.
9. (a) Starting with fundamentals develop the radar - range equation, under idealised conditions.
- (b) Explain briefly the factors which influence the radar range equation specially taking the effect of noise into consideration. Obtain the modified equation for maximum range taking the effect of them all noise.
- (c) Explain Doppler effect and describe how this effect is used in MTI radar.

10. Discuss any five of the following with detailed but precise notes:

- (a) Satellite communication
- (b) Shanon-Hartley relationship pertaining to the channel- capacity in communication systems
- (c) Type of modelation used for colour TV giving reason
- (d) Bridge Duplex Telegraphy
- (e) Dial tone and Busy tone circuits used in telephony
- (f) Optical fibres and the reasons for its use in tele-communications
- (g) Carrier current and its use in telegraph and telephone communications.