

ELECTRICAL ENGINEERING

PAPER—I

Full Marks : 200

Time : 3 hours

The figures in the margin indicate full marks

Candidates should attempt **five** questions out of **ten** questions. Question No. 1 is compulsory

1. Answer any *four* of the following :

- (a) (i) Determine the Thevenin equivalent circuit as viewed by the resistor R in the circuit of Fig. 1.
- (ii) What value of R is required for the maximum power to be dissipated by R ?
- (iii) What is the value of power in part (ii)?

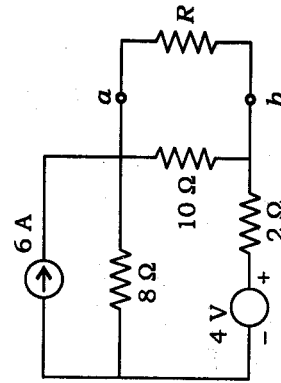


Fig. 1

10

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(2)

- (b) For R - L - C circuit shown in Fig. 2, the switch is closed at $t = 0$. Determine the nature of voltage across the capacitor if all initial conditions are zero. 10

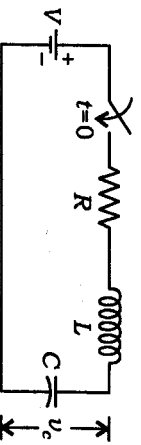


Fig. 2

- (c) Find the electric potential at a point on the axis of a uniformly charged circular disc whose surface charge density is σ . 10

- (d) What are meant by primary and secondary standards? With an example, explain how these are used in day-to-day life. 10

- (e) Represent p - n - p and n - p - n BJTs by their physical arrangement and schematic symbols indicating positive directions for currents.

A BJT has $\alpha = 0.99$, $i_B = I_B = 25 \mu\text{A}$ and $I_{CBO} = 200 \text{ nA}$. Find—

- (i) the d.c. collector current;
- (ii) the d.c. emitter current;
- (iii) the percent error in emitter current when leakage current is neglected. 10

(7)

- (iii) speed of the rotor magnetic field with respect to the rotor, (iv) speed of the rotor magnetic field with respect to the stator, (v) speed of the rotor field with respect to the stator field. 20

- (b) A 3- ϕ , Y-connected cylindrical rotor synchronous generator, rated at 10 kVA and 230 V, has a synchronous reactance of 1.2Ω per phase and an armature resistance of 0.5Ω per phase. Calculate the percent voltage regulation at full-load with 0.8 lagging power factor. 20

8. (a) State Barkhausen's criteria for oscillation.

The tuned circuit of L - C oscillator has a fixed inductance of $50\ \mu\text{H}$ and has to be tunable over a frequency band of 200 kHz to 1000 kHz. Find the range of variable capacitor required.

5+15

- (b) Explain the working of a bistable multivibrator and show how it can be used as a basic memory element for digital logic.

20

9. (a) Develop equivalent circuit of a 1- ϕ transformer with all basic assumptions. How do you measure the parameters of the equivalent circuit experimentally?

20

- (b) A shunt generator rated at 100 kW and 460 V was run as a motor on no-load at its rated voltage and speed. The total current taken from the supply is 9.8 A including a shunt field current of 2.7 A. The resistance at normal working temperature of the armature circuit was $0.11\ \Omega$. Find efficiency of the generator both at (i) half-load and (ii) full-load.

20

10. (a) A 3- ϕ , 50 Hz induction motor has 8 poles and operates with a slip of 0.05 for a certain load. Compute (in r.p.m.) the (i) speed of the rotor with respect to the stator, (ii) speed of the rotor with respect to the stator magnetic field,

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(Continued)

- (f) The stator of a 3- ϕ induction machine is connected to a 3- ϕ power supply. Show how a rotating flux is produced in the air gap. What happens if the supply sequence is changed?

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2. (a) In the circuit of Fig. 3, using nodal method, determine $v_o(t)$, where $i(t) = \sqrt{2} \times 10^{-4} \cos(4 \times 10^7 t)$.

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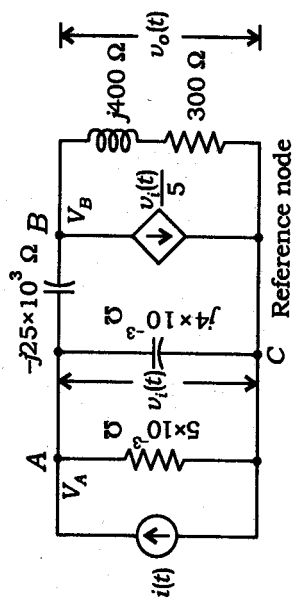


Fig. 3

- (b) For the parallel R - L - C circuit shown in Fig. 4, assume $R = 10\ \text{k}\Omega$, $L = 50.7\ \mu\text{H}$ and $C = 500\ \text{pF}$. Find the resonance frequency, quality factor, lower- and upper-half power frequencies, and bandwidth.

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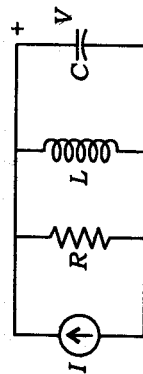


Fig. 4

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(4)

3. (a) For the impedance function given below, realize Foster I form network : 20

$$Z(s) = \frac{(s^2 + 1)(s^2 + 3)}{s(s^2 + 2)(s^2 + 4)}$$

- (b) Determine an R-C network from the driving-point impedance function

$$Z(s) = \frac{10(s+1)(s+3)}{s(s+2)(s+4)}$$

4. (a) A charge $Q_2 = 129 \times 10^{-9}$ C is placed in vacuum at a point $P_2(-0.03, 0.01, 0.04)$. Find the force on Q_2 due to a point charge $Q_1 = 110 \mu\text{C}$ at a point $P_1(0.03, 0.08, -0.02)$. 20

- (b) A long cylindrical wire of radius R carries a current i_0 distributed uniformly over the cross-sectional area. Determine B at a distance r from centre of the wire, $r < R$ and $r > R$. 20

5. (a) Represent Maxwell's equations in both integral and differential forms, expressing their physical meaning. Develop Laplace equation for free space. 20

- (b) Explain the functioning of Kelvin's double-bridge method to measure very low resistances. How do you increase accuracy of measurement? 20

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(Continued)

(5)

6. (a) Explain two-wattmeter method to measure 3- ϕ unbalanced power. 20

- (b) Develop an experimental scheme to localize an open-circuit fault in a cable. Indicate precautionary measure to be taken. 20

7. (a) The amplifier of Fig. 5 uses a silicon transistor for which $V_{BEQ} = 0.7$ V. Assuming that the collector circuit presents no limitation, classify the amplifier according to bias (Class A, AB, B or C) if—

- (i) $V_B = 1.0$ V, $v_s = 0.25 \cos \omega t$ (V)
 (ii) $V_B = 1.0$ V, $v_s = 0.5 \cos \omega t$ (V)
 (iii) $V_B = 0.5$ V, $v_s = 0.6 \cos \omega t$ (V)
 (iv) $V_B = 0.7$ V, $v_s = 0.5 \cos \omega t$ (V) 20

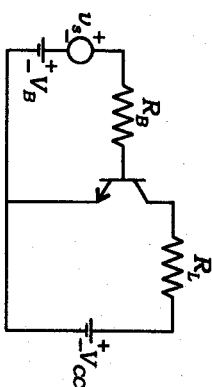


Fig. 5

- (b) If the emitter-base junction of a transistor is modelled as a forward-biased diode, express I_{Ee} in terms of emitter current. 20

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