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Question Paper Code : 70088

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Second Semester

Electrical and Electronics Engineering

EE 3251 — ELECTRIC CIRCUIT ANALYSIS

(Common to : Electronics and Instrumentation Engineering/Instrumentation and Control Engineering)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the power triangle for inductive load and capacitive load.
2. Give the procedure for nodal analysis of a circuit.
3. State Tellegen's theorem.
4. What is current division rule for resistances in parallel circuit?
5. What is meant by free and forced response?
6. Define damping ratio.
7. State Dot rule' for coupled circuits.
8. List out the characteristics of a parallel resonant circuit.
9. What is a phase sequence of three-phase system?
10. Write down the expression of neutral current in a unbalanced four-wire star connected load.

PART B — (5 × 13 = 65 marks)

11. (a) Determine loop currents in the network shown in Fig. Q.11 (a) using mesh current analysis. Also calculate the power loss in the 10 ohm resistor. [Fig. Q.11(a): triangle with left vertex, top vertex and right vertex; 8 ohm from left vertex to top; 3 ohm from top down to a bottom middle node; 5 ohm from top to right vertex; 15 V battery (+ on left) from left vertex to the bottom middle node; 2 ohm from the bottom middle node to right vertex; 10 ohm in an outer loop from the left vertex over the top to the right vertex; loop currents i_1 , i_2 and i_3]

Or

- (b) (i) A series RLC circuit has $R = 4.2 \text{ ohm}$, $L = 0.03 \text{ H}$, $C = 450 \text{ microF}$. If the circuit current $I = 10 \text{ A}$, find the voltage drop across each element, supply voltage and power factor. Also draw the phasor diagram. Assume the supply frequency is 50 Hz . (8)
- (ii) Find the amount of reactive power drawn by the circuit shown in Fig.Q.11 (b) (ii). [Fig. Q.11(b)(ii): $100 \angle 0^\circ \text{ V}$ source; 2 ohm and $j1 \text{ ohm}$ in series from c to a; between a and b, 2 ohm , $j5 \text{ ohm}$ and $-j1 \text{ ohm}$ in parallel] (5)
12. (a) (i) Reduce the given network shown in Fig. Q. 12(a)(i) using star-delta conversion technique and hence calculate the power loss in 1 ohm resistor. [Fig. Q.12(a)(i): 1 ohm from a to b; 2 ohm from b to c and 2 ohm from b to d; 3 ohm from c to d; 2 ohm from c to e and 2 ohm from d to e; 10 V battery between e and a, + towards a] (8)
- (ii) Find the current in the resistor R_L using the principle of superposition in Fig. Q. 12 (a) (ii). [Fig. Q.12(a)(ii): source $V_1 = 10 \angle 60^\circ \text{ V}$ in series with $j6 \text{ ohm}$ to a node; current source $I_1 = 2 \angle 0^\circ \text{ A}$ into that node; $R_L = 6 \text{ ohm}$ from that node to a $-j8 \text{ ohm}$ capacitor which returns to the bottom line] (5)

Or

- (b) In the circuit of Fig.Q.12 (b), find the current through load resistor R_L connected across x-y terminals using Thevenin's theorem. [Fig. Q.12(b): $20 \angle 0^\circ \text{ V}$ source in series with 5 ohm to the top line; $R_L = 5 \text{ ohm}$ between x (top) and y (bottom); a branch of 10 ohm in series with $j4 \text{ ohm}$ in parallel; current source $I_0 = 5 \angle 0^\circ \text{ A}$ on the right] (8)
13. (a) (i) A coil of resistance R and inductance L is in parallel with a capacitance C . Show that the effective resistance under the parallel resonant condition is L/RC . (8)
- (ii) Determine the resonant frequency and quality factor of a coil for the series circuit consisting of $R = 10 \text{ ohm}$, $L = 0.1 \text{ H}$ and $C = 10 \text{ } \mu\text{F}$. (5)

Or

- (b) (i) With necessary diagrams, derive the expression for mutual inductance in a single tuned circuit. (8)
- (ii) Two coils connected in series have an equivalent inductance of 0.4 H when connected in aiding and 0.2 H if connected in opposing. Calculate the mutual inductance of the coil. (5)
14. (a) In the circuit of Fig. Q.14 (a), the switch is closed on position-1 at $t = 0$ and after 1 time constant is moved to position-2. Find the transient current response before and after moving position-2. Assume that no initial charge on the capacitor. Also plot the transient current response. [Fig. Q.14(a): switch S connects either position 1, a 100 V source (+ at top), or position 2, a 100 V source of opposite polarity (- at top), to $R = 500 \text{ ohm}$ in series with $C = 20 \text{ microF}$; current $i(t)$] (8)

Or

- (b) In the circuit shown in Fig. Q. 14 (b), consists of series RC elements $R = 100 \text{ ohm}$, $C = 25 \text{ microF}$. A sinusoidal voltage $v(t) = 200 \sin(500t + \phi)$ volts is applied to the circuit at the time when phase angle $\phi = 0$. Determine the transient current response. [Fig. Q.14(b): source $v(t) = 200 \sin(500t + \phi)$ volts, switch S, $R = 100 \text{ ohm}$ and $C = 25 \text{ microF}$ in series, current $i(t)$] (5)

15. (a) With necessary phasor and circuit diagram, deduce the voltage, current, impedance and power relations in the three-phase balanced star connected system.

Or

- (b) Show that three-phase power can be measured by two watt meters in the balanced and unbalanced load. Draw the phasor diagrams. Also, derive an expression for power factor in terms of wattmeter readings.

PART C — (1 × 15 = 15 marks)

16. (a) Find the value of load impedance such that maximum power transfer takes place from source to load impedance in the circuit shown in fig. Q. 16(a). [Fig. Q.16(a): $100 \angle 0^\circ$ V source in series with $(2 + j1)$ ohm and a primary coil of $(5 + j2)$ ohm (mesh current I_1); secondary coil of $(5 + j8)$ ohm feeding load Z_L across terminals a-b (mesh current I_2); mutual reactance $j3$ ohm between the coils, dots at the top of both coils]

Or

- (b) A star connected alternator has 231 V/phase. It supplies a set of lighting loads at phase-R, having phase impedance of $40 \angle 0^\circ$ ohm, a capacitive load of $10 \angle -60^\circ$ ohm at phase-Y and an inductive load of $5 \angle 45^\circ$ ohm at phase-B. The loads are connected in delta. Obtain the phase currents, line currents and line voltages.