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Question Paper Code : 41027

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

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. What are the various powers available in the AC circuits? Also, write the expressions for these powers.
2. In the circuit shown in Fig. 1, compute the equivalent resistance between a and b. [Fig. 1: bridge with node c at top, d at left, e at right, f at bottom; 5 ohm from c to d, 6 ohm from c to e, 20 ohm from d to f, 3 ohm from e to f; terminal a connects to d through 10 ohm and terminal b connects to e through 8 ohm; nodes c and f are joined by a wire]
3. State Millman's Theorem.
4. Using current-division principle, determine the current i_1 in the circuit shown in Fig.2. [Fig. 2: current source is = 15 A feeding three parallel resistors $R_1 = 10$ ohm (carrying i_1), $R_2 = 30$ ohm and $R_3 = 60$ ohm]
5. Specify the condition for which the transient current in a series RLC circuit is oscillatory.
6. A series RL circuit consists of resistor of 30 ohm and inductor of 15 H. A constant voltage of 60 V is applied to the circuit at time $t = 0$. Obtain the current equation.
7. Write the expression for the bandwidth of a series RLC circuit.
8. Determine the maximum possible mutual inductance of inductively coupled coils with self-inductances, $L_1 = 25$ mH and $L_2 = 100$ mH.
9. Write the relationship between Line current, (I_L) and Phase current, (I_{ph}) in a delta connected system.
10. In two wattmeter method of three phase power measurement, the readings of wattmeter are 400 W and -35 W. Compute the power factor.

PART B — (5 × 13 = 65 marks)

11. (a) In the circuit shown in Fig.3, use mesh current analysis and find the power delivered to the 4 ohm resistor. [Fig. 3: triangular network with top node A and bottom node B; left branch: 80 V source and 2 ohm to A; middle branch: 3 ohm from A in series with 40 V source to B; right branch: 4 ohm from A in series with 100 V source; all three branches meet along the bottom line through B]

Or

- (b) Using node voltage method, determine the voltages at node 1 and 2 in the circuit shown in Fig. 4. [Fig. 4: 1 A current source into node 1; 2 ohm from node 1 to ground; 6 ohm between node 1 and node 2; 7 ohm from node 2 to ground; 4 A current source from node 2 to ground]
12. (a) For the circuit shown in Fig.5, find the resistance across the terminals a and b and determine the current, i using star-delta conversion method. [Fig. 5: 100 V source across terminals a-b; from a, 13 ohm to a top node; 24 ohm from top node down to a middle node and 30 ohm from the middle node to the bottom line; 10 ohm from top node down to a right node and 50 ohm from the right node to the bottom line; 20 ohm between the middle node and the right node; current i enters at a]

Or

- (b) Determine the voltage, V_0 in the circuit shown in Fig. 6 using superposition theorem. [Fig. 6: 24 V source in series with 2 ohm to a node; 4 A current source from that node to ground; 4 V source (+ on left) from that node to the output node; 4 ohm across the output, voltage V_0]
13. (a) A Series RC circuit as shown in Fig.7, has a DC input voltage, E applied to it at $t = 0$ seconds through switch. At the instant of switching, there is no initial charge on capacitor and the initial voltage across capacitor is zero. Derive and find the expression for the transient current, $i(t)$. Also, draw the transient response of the current. [Fig. 7: battery E , switch closing at $t = 0$, R and C in series, loop current i]

Or

- (b) A Series RLC circuit as shown in Fig.8 has a DC input voltage of E applied to it at $t = 0$ seconds through switch. Derive and find the expression for the transient current, $i(t)$ for the critically damped condition. Assume initial relaxed circuit conditions. [Fig. 8: battery E , switch closing at $t = 0$, R , L and C in series, loop current i]
14. (a) Draw the frequency response of a parallel RLC circuit shown in Fig.9 and derive the expression for bandwidth, B in terms of resistance, R and capacitance, C . [Fig. 9: AC source V supplying total current I_T to R , L and C in parallel with branch currents I_R , I_L and I_C]

Or

- (b) Derive the expression for equivalent inductance, L for the circuit shown in Fig. 10. L_1 , L_2 are the self-inductances and M is the mutual inductance. [Fig. 10: voltage V applied across L_1 and L_2 in parallel, total current i dividing into i_1 and i_2 , mutual inductance M between the coils, dots at the top of L_1 and the bottom of L_2]

15. (a) Three identical impedance are connected in star to a 3-phase balanced star connected supply of 400 V. Given that the line current is 35 A and the total real power absorbed is 15 kW. Determine the values of resistance and reactance of the star connected impedances. Note that the given supply voltage is line voltage.

Or

- (b) A 3-phase, 415 V, 50 Hz supply is applied across a delta connected circuit with an impedance of $4 + j6$ ohm in each phase. Determine the three phase power supplied to the delta connected circuit.

PART C — (1 × 15 = 15 marks)

16. (a) Determine current, I_0 in the circuit shown in Fig. 11 using mesh current analysis. [Fig. 11: three-mesh AC circuit; left side has a $5 \angle 0^\circ$ A current source (top mesh I_3) above an 8 ohm resistor (bottom mesh I_1); $j10$ ohm between meshes I_3 and I_1 ; $-j2$ ohm between meshes I_3 and I_2 and another $-j2$ ohm between meshes I_1 and I_2 ; 4 ohm in the top branch of mesh I_2 ; right branch has a $20 \angle 90^\circ$ V source with current I_0 flowing upward]

Or

- (b) For the circuit shown in Fig. 12, find the Thevenin's equivalent circuit and determine the voltage, V_o . [Fig. 12: 3 A current source in parallel with 16 ohm; 4 ohm series to a middle node; 5 ohm in series with a 12 V source from the middle node to the bottom line; 1 ohm series to a 10 ohm load across which V_o is taken]