B.I.E.E. 2nd Yr. 1st Semester Examination, 2025

SUBJECT: Circuit Theory

Total Time: Three hours

Full Marks 100

All Questions are Compulsory. Please read instructions for each Question.

CO1:Q1 CO2:Q2 CO3: Q3 CO4: Q4

Q.No.		Marks
1.	**Answer any 4:**	4x5=20

a) Determine the currents I_1, I_2 and I_3 in the circuit shown in Fig. 1a using nodal analysis.

b) Use mesh analysis to determine the current I in the circuit in Fig. 1b. Also determine the power dissipated in the two resistors.

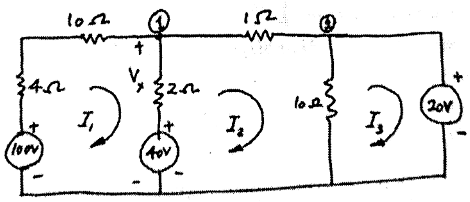


Fig. 1a

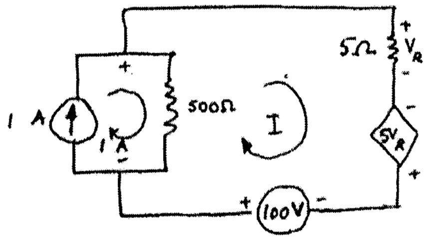


Fig. 1b

c) Find the least number of cells, each of emf 2.1V and internal resistance 0.5Ω to produce a current of 6A in an external resistance of 0.7Ω. Draw the schematic of the circuit. The cells may be combined in series or parallel or any other combination.

d) Determine $I_{9\Omega}$ using Thevenin's and Norton's theorem for the circuit shown in Fig. 1d.

e) Determine I_1 using Superposition theorem for the circuit shown in Fig. 1e.

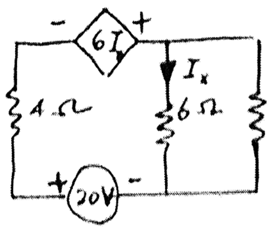


Fig. 1d

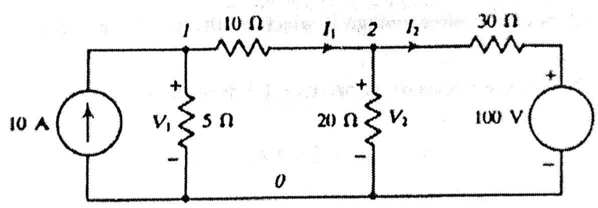


Fig. 1e

Q.No.		Marks
2.	**Answer any 4:**	4x6=24

a) An 8 μF capacitor is connected to a constant voltage source through a resistance of 1.5 MΩ. After being on charge for 24s, the capacitor is disconnected and discharged through a resistor. Determine what % of the supply input energy is dissipated in the resistor.

b) An iron plunger is drawn into a solenoid of resistance 50 Ω against a spring. 2.5A current flows into it nominally for a 250V, 50Hz supply. This drops to 1A when the plunger is drawn into the solenoid. Calculate i) impedance, ii) reactance, iii) inductance of solenoid and iv) stored energy for both positions of the solenoid.

Q.No.		Marks

2.

c) A series RLC circuit shown in Fig. 2c comprises of R = 45Ω, C = 14.28mF and L = 5H and a switch which closes at t = 0s, when the capacitor charges to 50V. Determine the initial conditions at $t = 0^+$ for i, v_C, v_L, v_R, di/dt. Also determine the general expressions for i(t) and $v_L(t)$ and their values at t = 0.5s.

d) A dc generator is connected to a parallel circuit of a 600Ω resistor and a coil of 200H, 300Ω as shown in Fig.2d The system is in steady state till the generator trips at t = 0s. At t = 1s, determine the current in the coil, voltage induced in the coil and the total voltage across the coil.

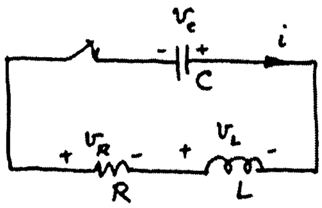


Fig. 2c

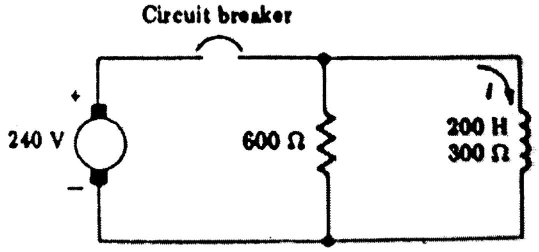


Fig. 2d

e) The circuit for a spark gap ignition system (Fig. 2e) consists of an electrolytic capacitor of 0.01μF, in series with the ideal resistanceless spark gap, a 1mH inductance, a 1.25kΩ resistance and a test object of 4kΩ. At the instant of spark gap breakdown, a surge generator has the capacitor charged to 200 kV. Find the current in the circuit and the voltage across the 4kΩ test object. What is the time to reach the peak test voltage? Also find the initial rate of rise of voltage.

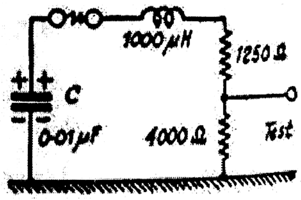


Fig. 2e

3. **Answer any 3:** 3x8=24

a) In the bridge circuit shown in Fig. 3a, calculate the current through the inductor, capacitor and the three resistors using a) nodal analysis OR b) mesh analysis. Determine the power supplied by the voltage source. Verify that this is dissipated entirely in the resistors.

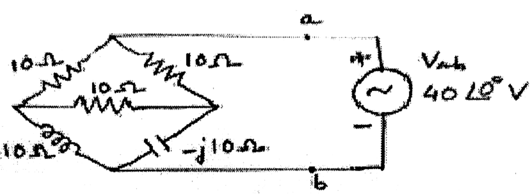


Fig. 3a

Q.No.		Marks
3.	b) On applying 100V at 50Hz, 8A current flows and 120W power is consumed in coil A while 10A current and 500W power is consumed in coil B. If this supply is applied to the series connection of coils A and B, determine the resultant current and power consumed.	
	c) A 220V 50 Hz inductive load draws 500W power at a pf angle of 30° lagging. State the complex power of the load. A capacitor C is connected across the load to bring the overall p.f. to 0.95 lagging. Determine the initial p.f, value of C, complex power drawn by C and new value of complex power of the load/capacitor combination.	
	d) Find the input admittance or impedance for the circuit in Fig. 3d. Then use this to determine the supplied voltage and hence the current through the 15 Ω resistor.	

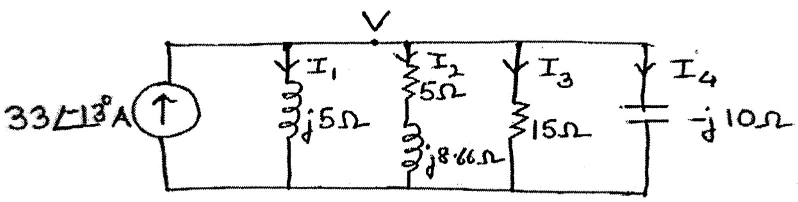


Fig. 3d

4.	**Answer any 4:**	4x8=32
	a) Determine the parameters of the equivalent T network to replace the transformer in Fig. 4a and draw the equivalent circuit. Determine the supply current.	

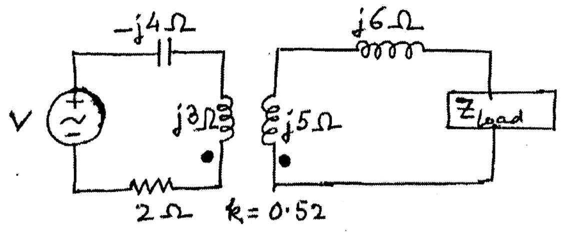
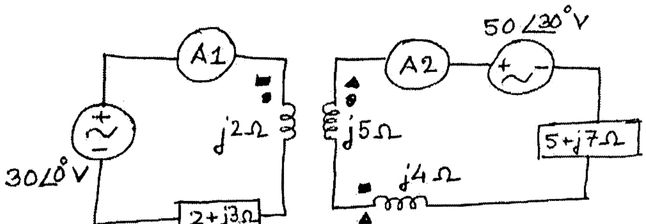


Fig. 4a

b) Determine the ammeter readings in the circuit in Fig. 4b. Determine the complex power drawn by the (5+j7)Ω impedance.



$X_{M\blacktriangle} = 4\Omega$, $X_{M\blacksquare} = 2\Omega$, $X_{M\bullet} = 3\Omega$

Fig. 4b

Q.No.		Marks
4.	c) Determine the mutual impedance X_M, mutual inductance M for the circuit in Fig. 4c for k=1. Draw the equivalent T-network circuit and determine the ammeter reading. d) Determine the initial conditions i_L, v_C and i_C at t=0+ for the circuit in Fig. 4d. Draw the Laplace equivalent circuit when the switch is closed at $t=0^+$ with initial conditions represented as sources. Using Laplace transform for the circuit, calculate i(t). e) In Fig 4e, the 3F and 6F capacitors are initially charged to 20V and 10V respectively. Draw the Laplace equivalent circuit for the circuit when the switch is closed at $t=0^+$ with initial conditions represented as sources. Using Laplace transform, determine the current I(s), $V_{3F}(s)$ and $V_{6F}(s)$ and their time-domain equivalents. Thereafter calculate voltages on the capacitors at t=1s.	

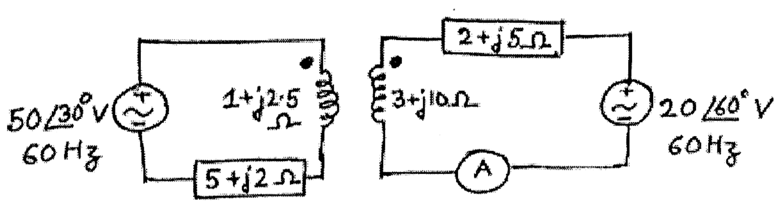


Fig. 4c

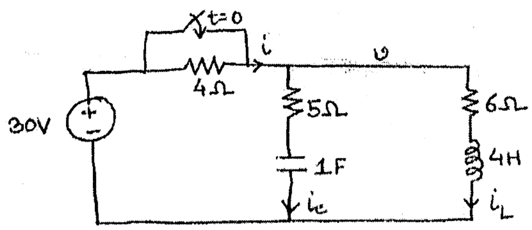


Fig. 4d

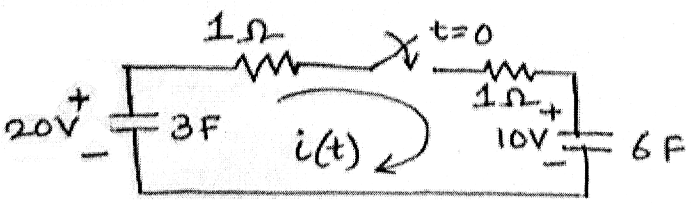


Fig. 4e