Ref. No. Ex/IEE/PC/B/T/212/2024

B.I.E.E. 2nd Yr. 1st Semester Examination, 2024

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:**	4x7=28

a) Find the Thevenin equivalent of the ckt. in Fig. 1a wrt *ab* and determine I through the 10Ω resistor.

b) Find the Norton equivalent in Fig. 1b at terminals *ab* for

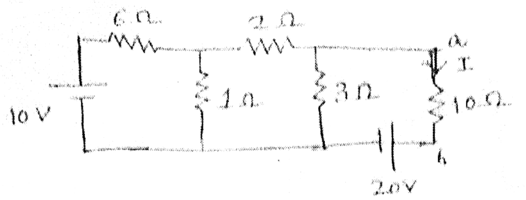


Fig. 1a

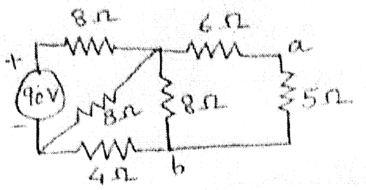


Fig. 1b

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) A voltage source of 15V and internal resistance 10kΩ is connected across a 20kΩ resistance R. Determine ideal voltage drop V_0 across R. A voltmeter of range 0-10V with 1kΩ/V sensitivity is used to measure V_0. What is the effective meter resistance R_m? What is the voltmeter reading and deviation (in %) from ideal value? Determine R_m, the voltmeter reading and deviation (in %) from ideal value if this is replaced by a voltmeter in same range but higher sensitivity of 200kΩ/V?

e) For the 2-stage amplifier circuit in Fig. 1e, use mesh analysis to determine i) $R_{in}=v_{in}/i_b$, ii) voltage gain v_{out}/v_{in} and iii) voltage v across the dependent source.

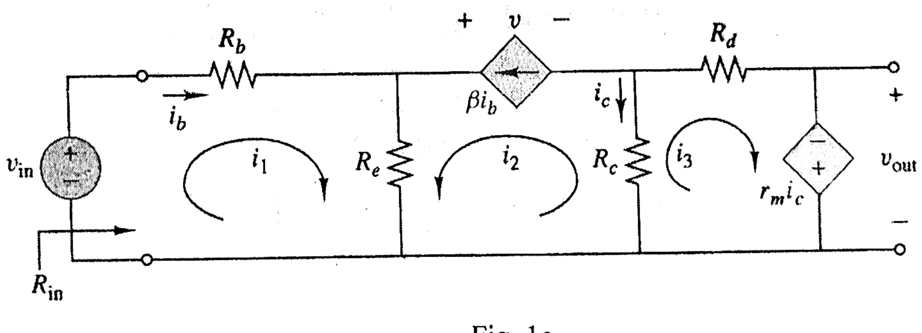
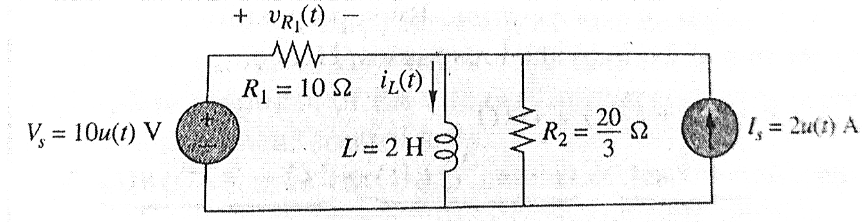
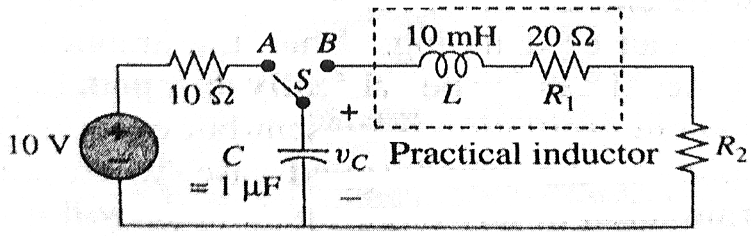
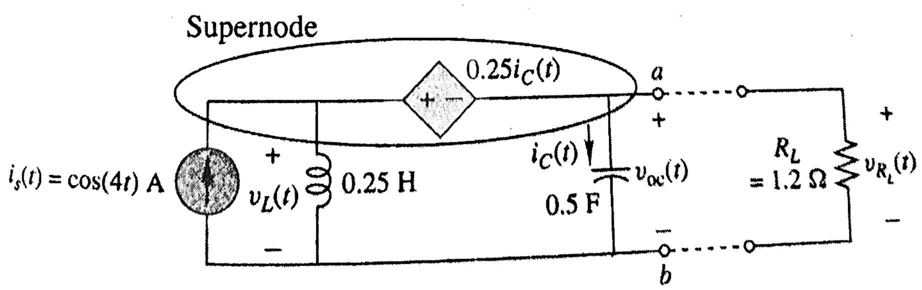


Fig. 1e

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

Q.No.		Marks
2.	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. c) Using superposition, determine $i_L(t)$ for $t \geq 0$ in Fig. 2c considering $i_L(0^-) = -1A$.  Fig. 2c d) For the RLC circuit in Fig. 2d, the switch is moved from position A to B at t=0. Determine $v_C(t)$ for $t \geq 0$ for the 3 values of load resistance R_2, namely i) 405Ω, ii) 0Ω and iii) 180Ω.  Fig. 2d	
3.	**Answer any 3:** a) 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. b) Draw the sinusoidal steady state equivalent circuit for Fig. 3b. Using supernode, determine $V_{oc}(j\omega)$, $I_{SC}(j\omega)$, $Z_{th}(j\omega)$ when ω=4 rad/s and draw Thevenin equivalent circuit. Using this, determine $v_L(t)$ for load R_L=1.2Ω.  Fig. 3b	3x8=24

Q.No.		Marks

3.

c) In the circuit shown in Fig. 3c, v_s=141.1sin(4000t)V p-p and i_s=4sin(4000t+45°)A p-p. Draw the sinusoidal equivalent circuit in terms of the rms values. Determine the currents through and the voltages across all elements in sinusoidal form (rms) and time-domain (p-p) using i) nodal analysis OR ii) mesh analysis.

d) A 230V 60 Hz inductive load draws 45kW at 0.75 lagging p.f. A capacitor C is connected across the load to bring the overall p.f. to 0.9 lagging. Determine new value of complex power of the load/capacitor combination and the value of C in mF.

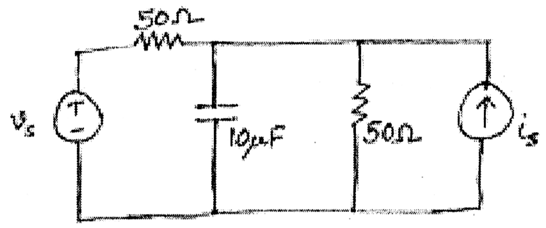


Fig. 3c

4.

Answer any 3: 3x8=24

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

b) Determine the mutual impedance X_M, mutual inductance M and the ammeter reading for the circuit in Fig. 4b for k=1.

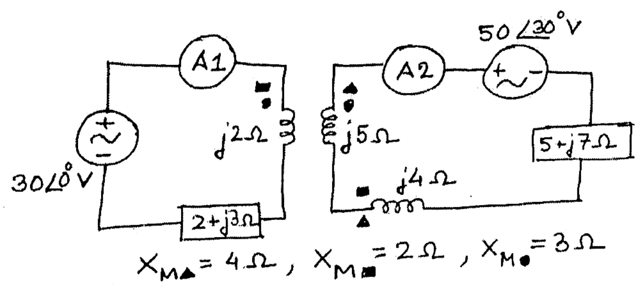


Fig. 4a

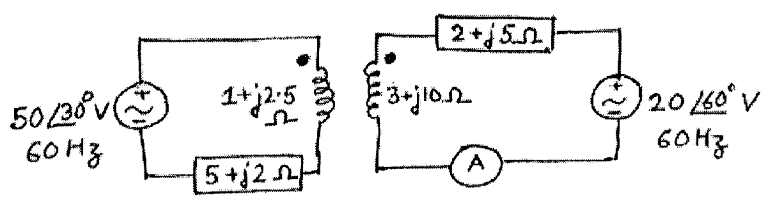


Fig. 4b

Q.No.		Marks
4.	c) Three resistors of 3, 4, 5 Ω respectively are star connected to a 3-phase 400V symmetrical system, phase sequence RYB. Find i) the currents in each resistor, ii) the power dissipated in each resistor iii) the phase angles between the currents and the corresponding voltages iv) star point potential.	
	d) Using Laplace transform for the circuit in Fig. 4d, calculate i(t). Determine the initial conditions i_L, v_C and i_C at t=0+.	
	OR	
	Determine the initial conditions at t=0+ for Fig 4e when the switch S is closed. Draw the Laplace equivalent circuit with initial conditions represented as sources. Using Laplace transform, determine the current $I_2(s)$ using i) mesh analysis OR ii) Thevenin's theorem. Calculate $i_2(t)$ at t=0.1s.	

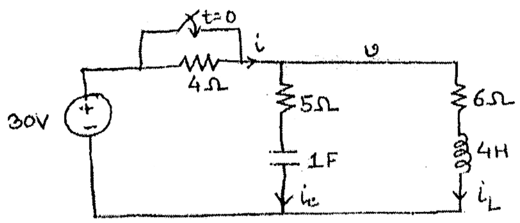


Fig. 4d

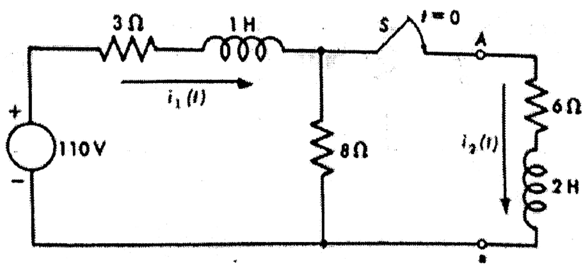


Fig. 4e