Ref. No. Ex/IEE/PC/B/T/212/2023

B.I.E.E. 2nd Yr. 1st Semester Examination, 2023

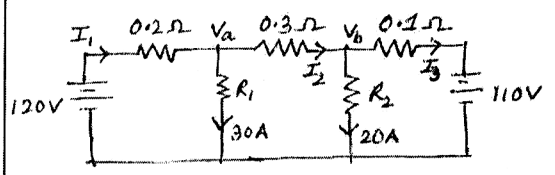
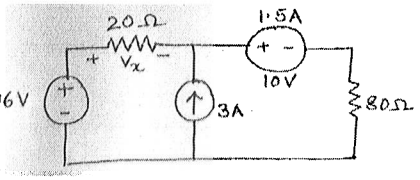
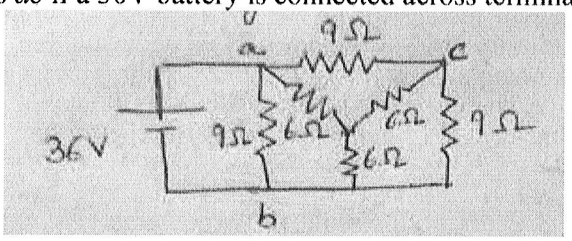
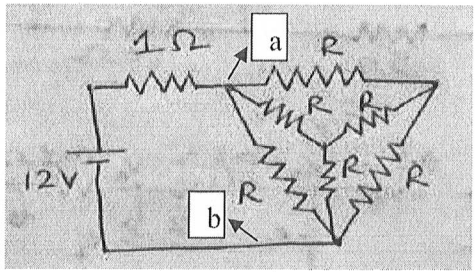
SUBJECT: Circuit Theory

Total Time: Three hours

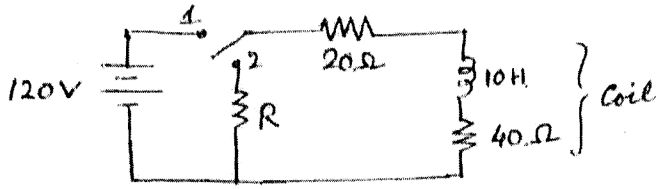
Full Marks 100

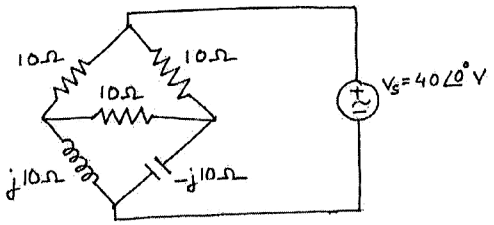
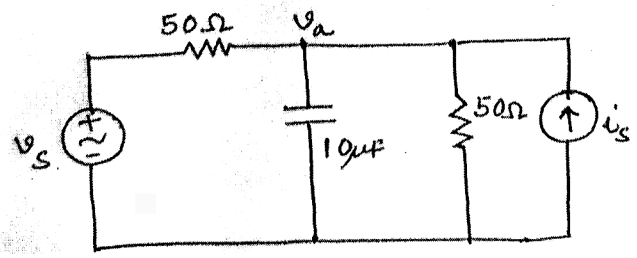
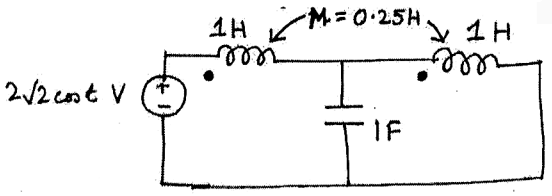
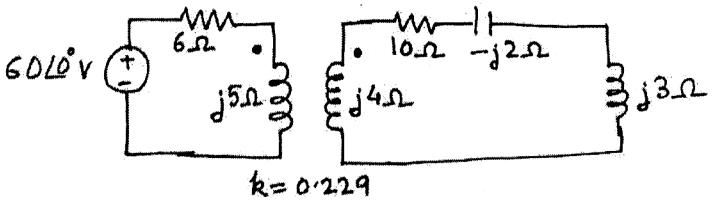
All Questions are Compulsory.

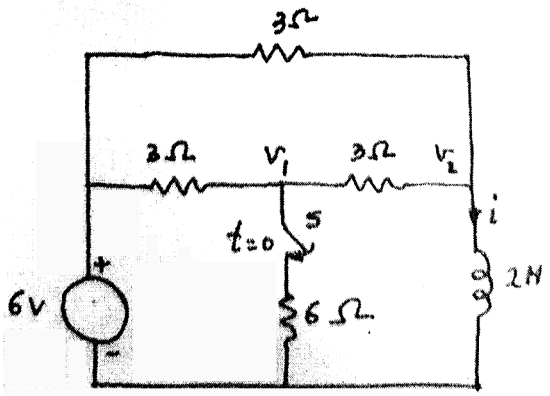
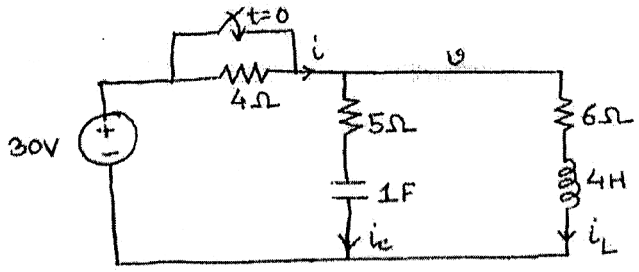
CO1:Q1,2 CO2:Q3,4 CO3: Q6 CO4: Q5,7,8

Q.No.		Marks
1.	a) (i) Use nodal analysis to determine I1, I2, I3, Va, Vb in the circuit in Fig. 1.	5+5
	(ii) Use Thevenin's Theorem to find the value of Vx in the circuit shown in Fig. 2. The rating of the source in series with the 80Ω resistor is 10V, 1.5A.	
	OR	
	b) (i) Use mesh analysis to determine I1, I2, I3, Va, Vb in the circuit in Fig. 1.	5+5
	(ii) Use Superposition Theorem to find the value of Vx in the circuit shown in Fig. 2. The rating of the source in series with the 80Ω resistor is 10V, 1.5A.	
	 Fig. 1	
	 Fig. 2	
2.	a) (i) Determine resistance across terminals *ab*. Calculate voltage across terminals *ac* if a 36V battery is connected across terminals *ab*.	5+5
		
	(ii) A 250V d.c. supply in series with a 0.5 Ω resistor is used to charge 100 cells of 2.2V, 0.01 Ω rating each. Calculate the charging current and the power dissipated in a) heating the cells, b) charging the cells and c) heating the resistor.	
	OR	
	b) (i) Determine R so that power into terminals *ab* is maximum. Calculate maximum power.	5+5
		
	(ii) Two resistors R1=2500Ω and R2= 4000Ω are joined in series and connected to a 100V supply. The voltage drops across R1 and R2 are measured successively by a voltmeter having a resistance of 50000Ω. Find the sum of the two readings.	

[Turn over

Q.No.		Marks
3.	a) Derive the natural response i(t) for the underdamped series RLC circuit and draw detailed response. State from derivation and indicate the following in the figure: (i) starting value (ii) upper and lower envelopes with their maximum values (iii) maximum overshoot and (iv) peak time and (v) 5% tolerance band.	10
	b) (i) A 50 μF capacitor is discharged through a 100 kΩ resistor. If the capacitor was charged to 400V initially, then (i) find initial energy stored W_0, (ii) time constant τ, (iii) expression for energy stored in capacitor $w_C(t)$ in terms of W_0, t and τ and (iv) energy stored after 600ms. How long will it take for the capacitor to discharge to 0.072 J?	5
	OR	
	(ii) For the RL circuit in Fig. below, the switch is moved from position 1 to 2 at t=0. a) Find the voltage across the coil at the instant of changeover for R=500Ω. b) What is the value of R for this voltage to be 120V? c) For the value of R as in b), determine the time taken to dissipate 95% of the stored energy.	5
		
4.	a) The circuit for a spark gap ignition system consists of an electrolytic capacitor of 0.01μF, in series with the ideal resistanceless spark gap, a 1mH inductance, a 1.25k Ω 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.	10
	OR	
	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.	10
5.	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.	5
	b) (i) The voltages across a resistor, an inductor coil and a capacitor of a series RLC circuit are 170, 150 and 100V resp. and the current is 4A when 200V is applied across it. Consider the inductor as a coil with associated coil resistance. The capacitor can to be considered to be ideal. Determine power factors of the inductor and the circuit.	10
	OR	
	(ii) A capacitance C of 20μFis connected in series to a resistance R and an iron cored inductor L. The current through the circuit is 0.345A The drops across the R, L and C elements are 25V, 40V, 55V while the drop across the R and L elements is 50V. Find (i) the applied voltage, (ii) frequency and (iii) loss in L.	10

Q.No.		Marks
6.	a) In the bridge circuit shown, calculate the current through the inductor, capacitor and the three resistors using (i) nodal analysis OR (ii) mesh analysis. How much is the power supplied by the voltage source? 	10
	b) In the circuit below, $v_s=141.4 \sin 4000t$V, $i_s=4 \sin (4000t+45)$A. Draw the sinusoidal representation of the circuit. Using sinusoidal analysis, determine the currents through and the voltages across each element using (i) nodal analysis OR (ii) mesh analysis. 	10
7.	a) Draw the sinusoidal equivalent circuit. Write the mesh equations and use them to find the mesh currents and voltage across the capacitor. 	10
	OR	
	b) Write the mesh equations, use them to find currents in primary and secondary circuits and determine the input impedance from first principles. 	10

Q.No.		Marks
8.	a) Draw the Laplace equivalent circuit with initial conditions represented as sources. Determine the initial conditions at t=0+ when the switch S is closed. Using Laplace transform, write the nodal equations and determine I(s). Calculate i(t). The resistance between the 6V source and V_1 is 3Ω. 	10
	OR	
	b) Using Laplace transform, calculate i(t). Determine the initial conditions i_L, v_C and i_C at t=0+. 	10