Ref. No. Ex /IEE/PC/B/T/212/2024(S)

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

SUBJECT: Circuit Theory

Total Time: Three hours

Full Marks 100

All Questions are Compulsory.

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

| Q.No. | | Marks |
|---|---|---|
| 1. | a) In the ckt. of Fig. 1a, find the Thevenin equivalent of wrt *ab* and determine I through the 10Ω resistor. | 8 |

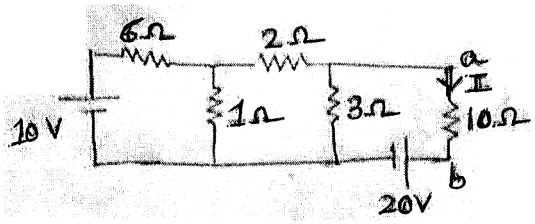



Fig. 1a

OR

Find the Norton equivalent at terminals *ab* for the circuit in Fig. 1b. 8

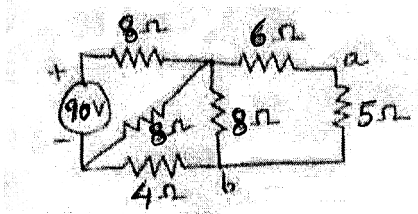



Fig. 1b

b) 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? 10

OR

For the 2-stage amplifier circuit in Fig. 1c, 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. 10

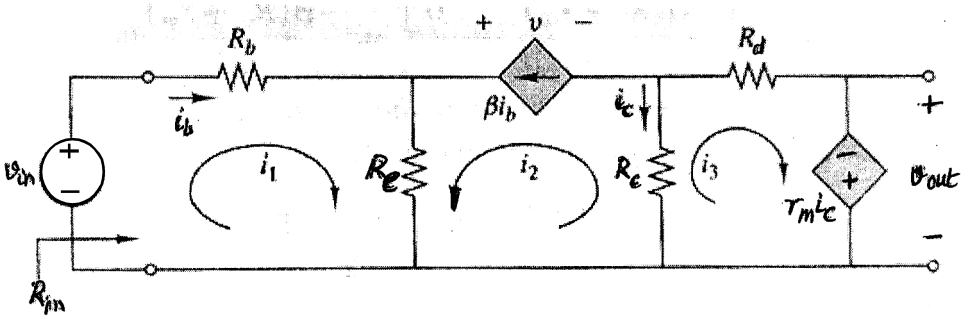
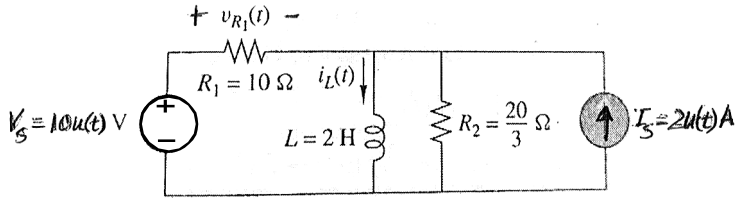
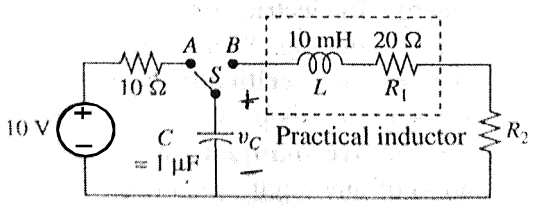
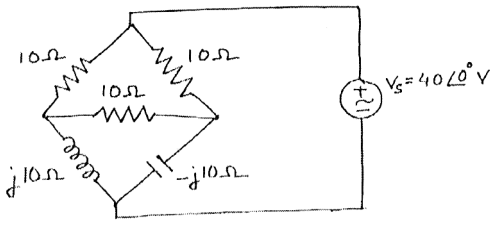
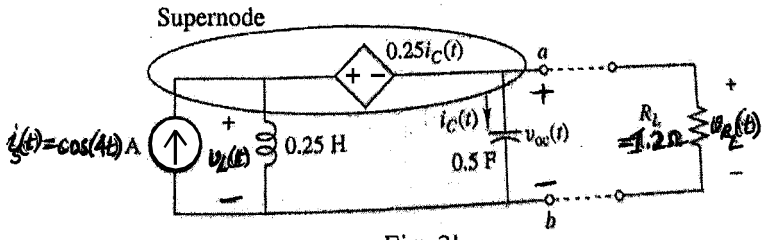
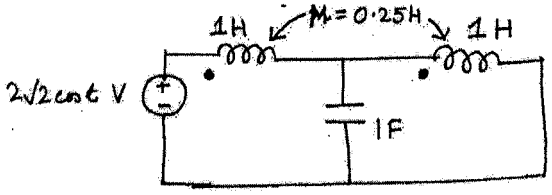
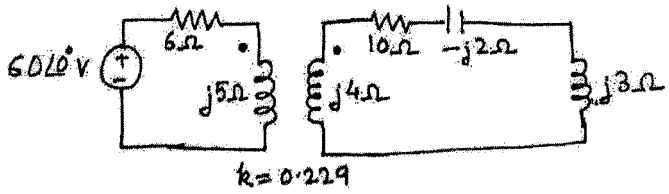
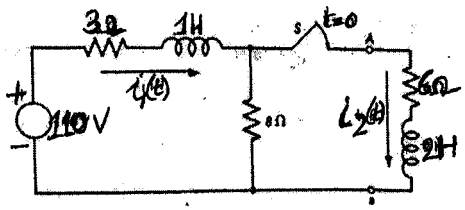
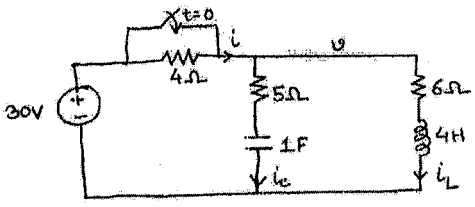



Fig. 1c

[ Turn over

| Q.No. | | Marks |
|---|---|---|
| 2. | a) 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? | 12 |
| | OR | |
| | 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. | 12 |
| | b) Using superposition, determine $i_L(t)$ for $t \geq 0$ in Fig. 2a considering $i_L(0^-) = -1A$. | 14 |
| |  | |
| | Fig. 2a | |
| | OR | |
| | For the RLC circuit in Fig. 2b, 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. | 14 |
| |  | |
| | Fig. 2b | |
| 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. | 12 |
| | OR | |
| | In the bridge circuit shown in Fig. 3a, calculate the current through the inductor, capacitor and the three resistors. How much is the power supplied by the voltage source? | 12 |
| |  | |
| | Fig. 3a | |

| Q.No. | | Marks |
|---|---|---|
| 3. | 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 $\omega$=4 rad/s and draw Thevenin equivalent circuit. Using this, determine $v_L(t)$ for load $R_L$=1.2Ω. | 10 |
| |  | |
| | Fig. 3b | |
| | c) 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. | 8 |
| 4. | a) Write the mesh equations (Fig. 4a). Find the voltage across the capacitor. | 12 |
| |  | |
| | Fig. 4a | |
| | OR | |
| | Write the mesh equations (Fig. 4b). Find the input impedance. | 12 |
| |  | |
| | Fig. 4b | |
| | b) Determine the initial conditions at t=0+ for Fig. 4c when the switch S is closed. Draw the Laplace equivalent circuit with initial conditions represented as sources. Using Laplace transform, determine the current $I_2(s)$. Calculate $i_2(t)$ at t=0.1s. | 14 |
| | OR | |
| | Using Laplace transform, calculate i(t) for Fig. 4d. Determine the initial conditions $i_L$, $v_C$ and $i_C$ at t=0+. | 14 |
| |  | |
| | Fig. 4c | |
| |  | |
| | Fig. 4d | |