

Shahjalal University of Science and Technology
Department of Physics
B.Sc. Honours Fourth Year, Second Semester Final Examination-2022
Course Code: PHY 455 Session: 2020-2021
Course Title: Optoelectronics

Total Marks: 60 Credits: 3.0 Total Time: 3 Hours

*[Answer **all** the questions. The figure in the right margin indicate full marks.]*

1. (a) If you want to put two or more figures side by side then you can use the latex minipage environment. What is super Node? What is the difference between Super Mesh & Mesh? 2
- (b) Using nodal analysis, determine the potential across the $4\ \Omega$ resistor in Fig. 1 4

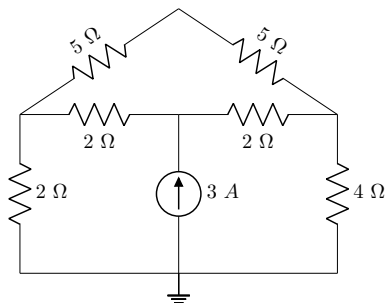


Fig. 1

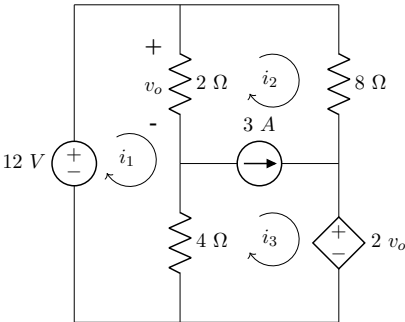


Fig. 2

- (c) Use mesh analysis to find currents and voltage v_o in the circuit of Fig. 2 4
2. (a) State Thevenin's Theorem. 1
- (b) Two resistors of values $1\ \text{k}\Omega$ and $4\ \text{k}\Omega$ are connected in series across a constant voltage supply of $100\ \text{V}$. A voltmeter having an internal resistance of $12\ \text{k}\Omega$ is connected across the $4\ \text{k}\Omega$ resistor. Draw the circuit and calculate: 4
- (i) True voltage across $4\ \text{k}\Omega$ resistor before the voltmeter was connected.
 - (ii) Actual voltage across $4\ \text{k}\Omega$ resistor after the voltmeter is connected and voltage recorded by the voltmeter.
 - (iii) change in supply current when voltmeter is connected.
 - (iv) Percentage error in voltage across $4\ \text{k}\Omega$ resistor.
- (c) If you want to insert a Figure(pdf, png, etc) then you can use the **includegraphics** command as shown below. : Find the rms value of the current waveform of Fig.3. If the current flows through a $9\ \Omega$ resistor, calculate the average power absorbed by the resistor. 5

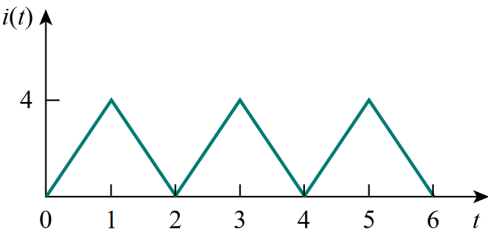


Fig. 3

3. (a) If you want to place two figures side by side then use minipage environment. As for example: For the circuit shown in Fig. 4, calculate the current in the $10\ \Omega$ resistance. Use Thevenin's theorem only. 4

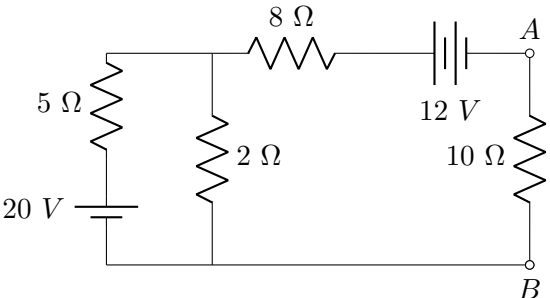


Fig. 4: Circuit for Thevenin's Theorem

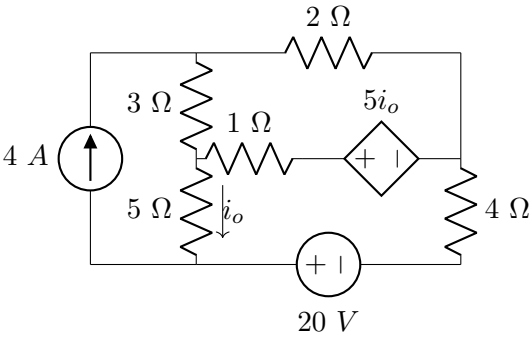


Fig. 5: Circuit for Superposition Theorem

- (b) What is super position theorem? Find i_o in the circuit in Fig. 5 using the superposition theorem.4
- (c) If a table is needed to insert, then you can use either tabular or tabulrx. In the table as shown in Table 1, the data are given for a general purpose Silicon diode, draw the I-V characteristic curve.2

Table 1: Your Table Title Here

SL.no	Forward bias voltage (V)	Forward bias current(mA)
1	0	0
2	0.2	0.0
3	0.4	0.1
4	0.5	0.5
5	0.53	1.0
6	0.6	8.2
7	0.66	19.5
8	0.7	53.5
9	0.71	83.1
10	0.73	112.7

OR

- (a) Find the Thevenin’s equivalent circuit of Fig. 6 to the left of the terminal.4

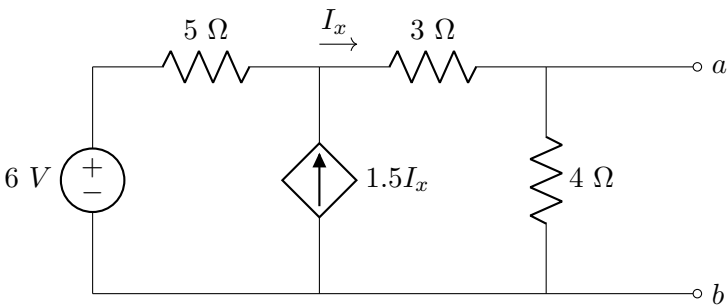


Fig. 6

- (b) Find the magnitude R_L for the maximum power transfer in the circuit shown in Fig. 7. Also find out the maximum power.4

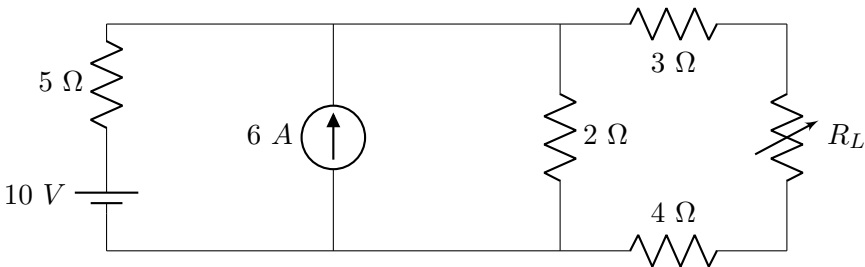


Fig. 7

- (c) Write short notes on Real power and Reactive power.2

4. (a) Determine I_{BQ} , I_{CQ} , V_{CEQ} , V_B , V_C and V_{BC} for the fixed-bias configuration shown in Fig. 8. 4

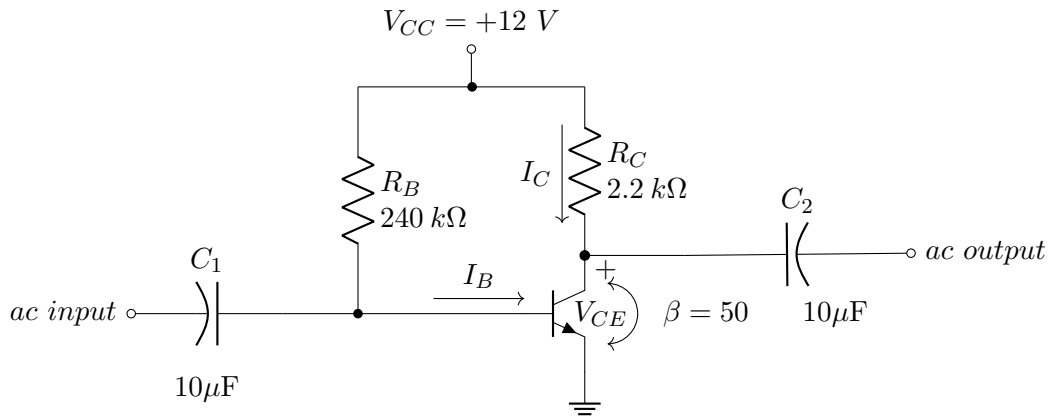


Fig. 8

- (b) Determine the saturation level for the network of Fig. 8. 2
- (c) For the emitter bias network of Fig. 9 determine I_B , I_C , V_{CE} , V_C , V_E and V_B for the fixed-bias configuration shown in 4

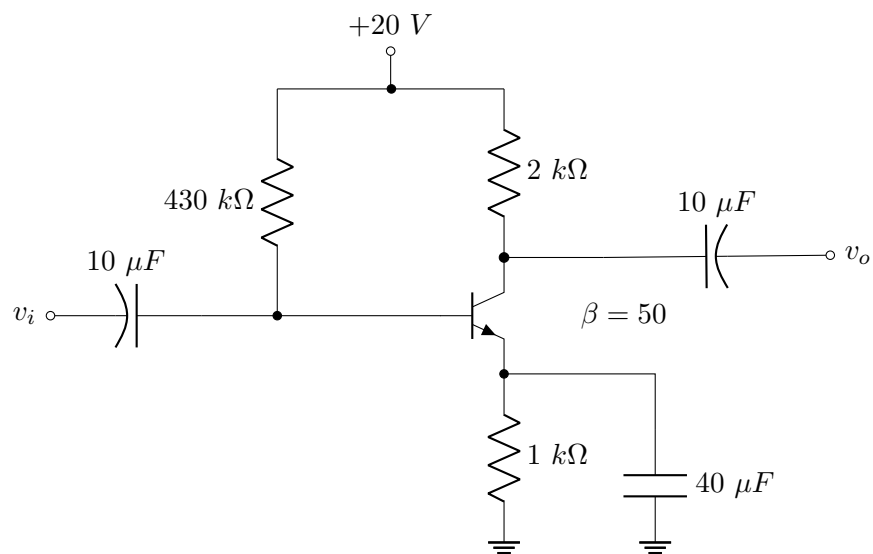


Fig. 9

5. (a) For the circuit in Fig. 10, $i(t) = 4(2 - e^{-10t})$ mA. If $i_2(t) = -1$ mA, find: 4
- (i) $i_1(t)$, (ii) $v(t)$, $v_1(t)$ and $v_2(t)$, and (iii) $i_1(t)$ and $i_2(t)$.

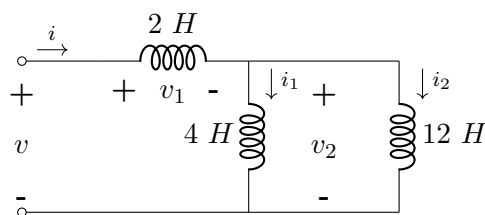


Fig. 10

- (b) Find i_x in the circuit of Fig. 11 using nodal analysis. 3

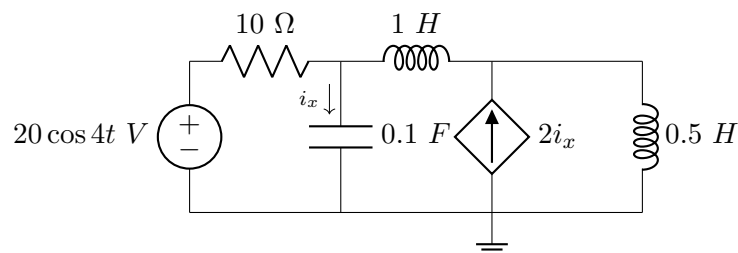


Fig. 11

- (c) Determine the currents I_1 , I_2 and I_{D2} for the network of Fig. 12. 3

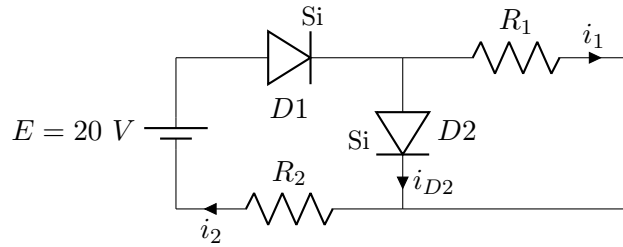


Fig. 12

6. (a) Simplify the Boolean function $F(w, x, y, z) = \sum(1, 3, 7, 11, 15)$. Which has don't-care condition: $d(w, x, y, z) = \sum(0, 2, 5)$. 4
- (b) Simplify $F(A, B, C, D) = \sum(0, 1, 2, 5, 8, 9, 10)$ in product of sums. 4
- (c) Define Minterms and Maxterms and briefly explain De Morgan's law. 2

OR

- (a) Simplify the Boolean function $F(w, x, y, z) = \sum(0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 14)$. 4
- (b) Suppose you have 3 friends. Design an alarm which will ring when more than one friend come. 4
- (c) Draw the symbol and truth table of EX-OR gate & EX-NOR gate. 2½

List of the relevant equations:

$$\begin{bmatrix} A_r \\ A_\theta \\ A_\phi \end{bmatrix} = \begin{bmatrix} \sin \theta \cos \phi & \sin \theta \sin \phi & \cos \theta \\ \cos \theta \cos \phi & \cos \theta \sin \phi & -\sin \theta \\ -\sin \phi & \cos \phi & 0 \end{bmatrix} \begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix}$$

$$\begin{aligned} \nabla \times \mathbf{A} &= \frac{1}{r \sin \theta} \begin{vmatrix} \hat{r} & r\hat{\theta} & r \sin \theta \hat{\phi} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \phi} \\ A_r & rA_\theta & r \sin \theta A_\phi \end{vmatrix} \\ &= \frac{1}{r \sin \theta} \left[\hat{r} \left(\frac{\partial}{\partial \theta} (\sin \theta A_\phi) - \frac{\partial A_\theta}{\partial \phi} \right) + \hat{\theta} \left(\frac{1}{\sin \theta} \frac{\partial A_r}{\partial \phi} - \frac{\partial}{\partial r} (r A_\phi) \right) \right. \\ &\quad \left. + \hat{\phi} \left(\frac{\partial}{\partial r} (r A_\theta) - \frac{\partial A_r}{\partial \theta} \right) \right] \end{aligned}$$

$$\begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix} = \begin{bmatrix} \sin \theta \cos \phi & \cos \theta \cos \phi & -\sin \phi \\ \sin \theta \sin \phi & \cos \theta \sin \phi & \cos \phi \\ \cos \theta & -\sin \theta & 0 \end{bmatrix} \begin{bmatrix} a_r \\ a_\theta \\ a_\phi \end{bmatrix}.$$