# Shahjalal University of Science and Technology
## Department of Physics
### First Year First Semester Final Examination, 2022
**Course Code:** PHY 07131121      **Session:** 2020-2021
**Course Title:** Quantum Electronics

| 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 Ω resistor in Fig. 1    4
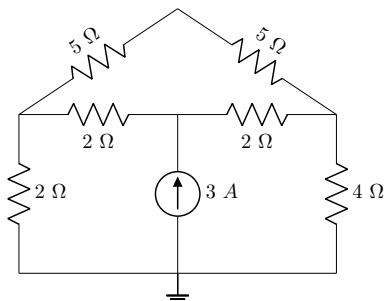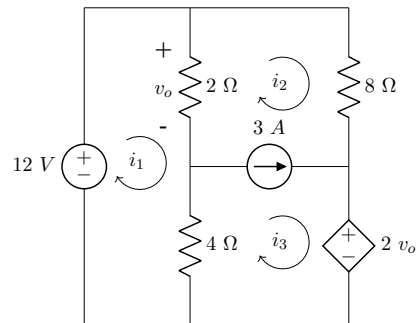


Fig. 1            Fig. 2

(c) Use mess 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 kΩ and 4 kΩ are connected in series across a constant voltage supply of 100 V. A voltmeter having an internal resistance of 12 kΩ is connected across the 4 kΩ resistor. Draw the circuit and calculate:    4

  (i) True voltage across 4 kΩ resistor before the voltmeter was connected.

  (ii) Actual voltage across 4 kΩ 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 kΩ 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 Ω resistor, calculate the average power absorbed by the resistor.    5
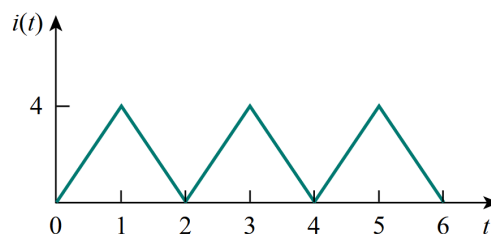


Fig. 3

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 Ω resistance. Use Thevenin's theorem only.    4
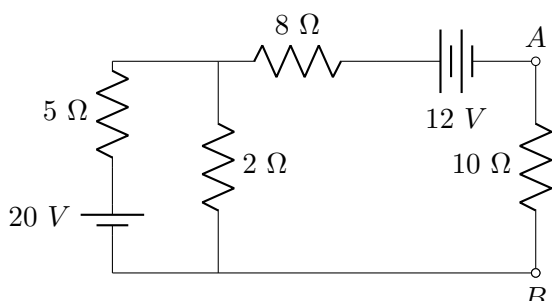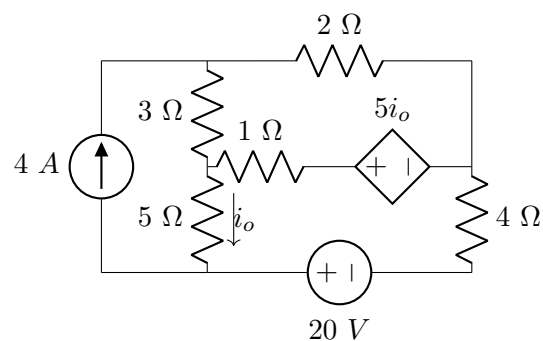


Fig. 4: Circuit for Thevenin's Theorem        Fig. 5: Circuit for Superposition Theorem

(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



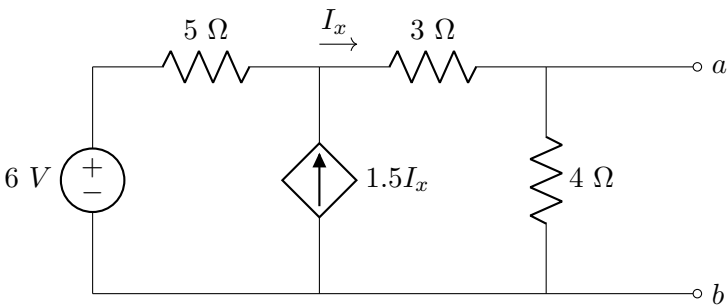Fig. 6

(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
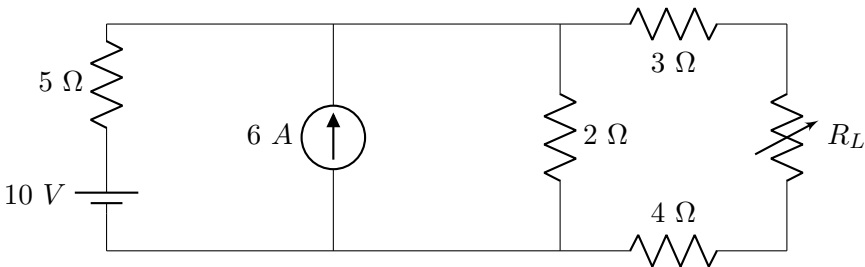


Fig. 7

(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
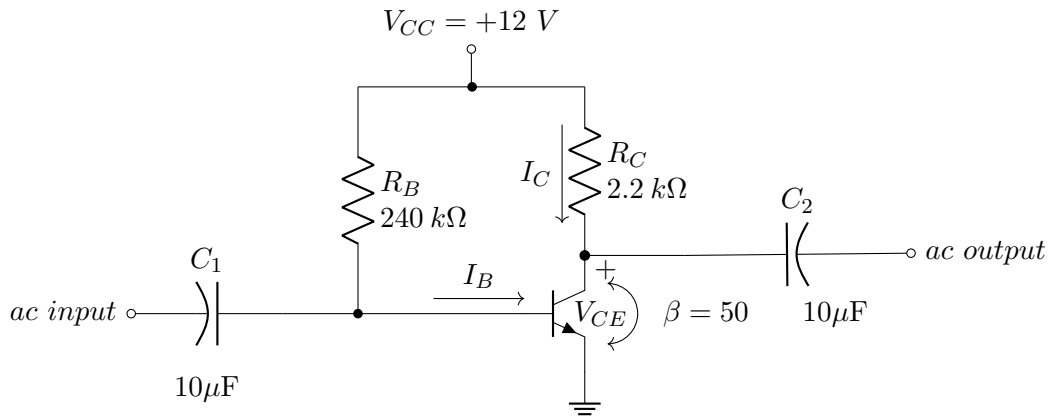


Fig. 8

(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
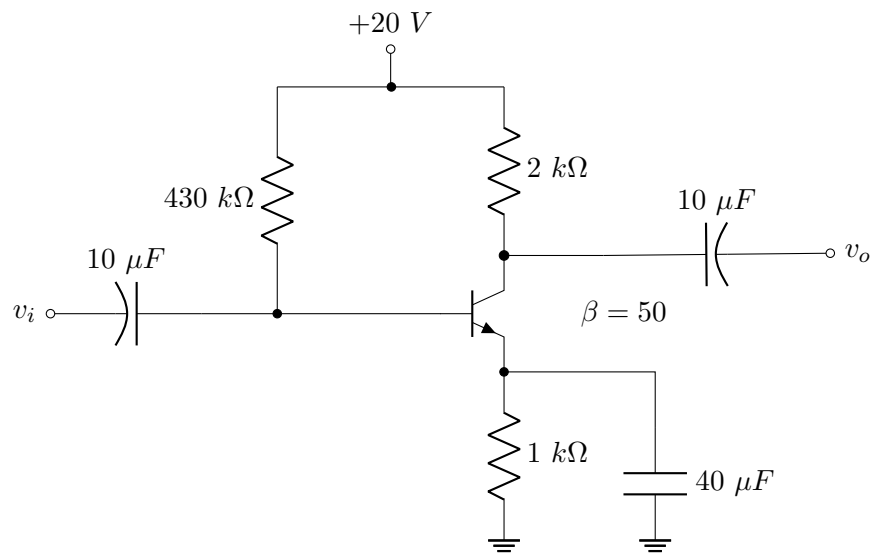


Fig. 9

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 $i_2(t)$.
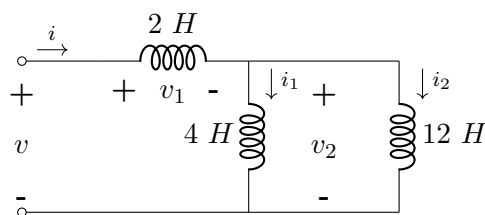


Fig. 10

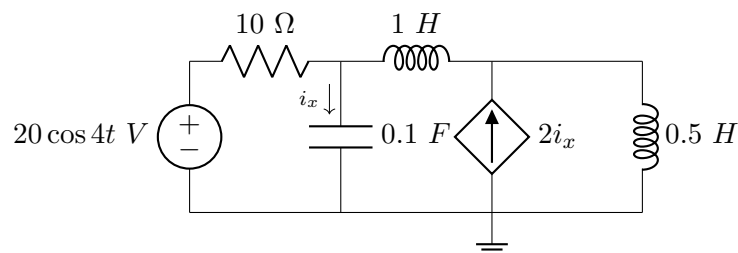(b) Find $i_x$ in the circuit of Fig. 11 using nodal analysis. — 3



Fig. 11

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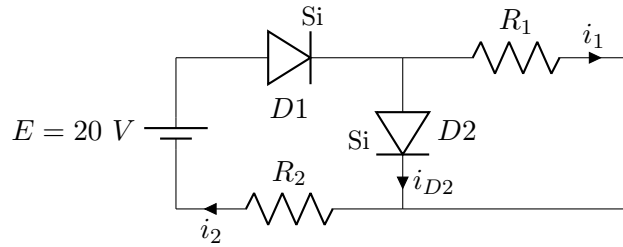
Fig. 12

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.   $2\frac{1}{2}$

### List of the relevant equations:

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

$$\nabla \times \mathbf{A} = \frac{1}{r\sin\theta} \begin{vmatrix} \hat{r} & r\hat{\theta} & r\sin\theta\hat{\phi} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \phi} \\ A_r & rA_\theta & r\sin\theta A_\phi \end{vmatrix}$$

$$= \frac{1}{r\sin\theta}\left[ \hat{r}\left( \frac{\partial}{\partial\theta}(\sin\theta A_\phi) - \frac{\partial A_\theta}{\partial\phi} \right) + \hat{\theta}\left( \frac{1}{\sin\theta}\frac{\partial A_r}{\partial\phi} - \frac{\partial}{\partial r}(rA_\phi) \right) \right.$$

$$\left. + \hat{\phi}\left( \frac{\partial}{\partial r}(rA_\theta) - \frac{\partial A_r}{\partial\theta} \right) \right]$$

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