

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

1. (a) What are luminescent and photo-luminescent processes? 2
- (b) How is the concept of quasi-Fermi level useful in semiconductors? 2
- (c) If you want the marks to be displayed as 2 + 2, use the command `\bdpart[2+2]` instead of the regular `\part[]` command. As for example: What is molecular orbital? Explain bonding and anti-bonding in molecular orbital. 2+2
- (d) If you want the subparts of the question to be appeared inline the use the command `\begin{inlinesubparts} \item, \item, etc.---\end{inlinesubparts}`. As for example: Draw schematic diagrams to show splitting of two molecular orbitals due to resonance interactions with the orbitals: (i) having same energy, and (ii) having different energies. 2+2
2. (a) For units, you can use SI unit, as for example 2  $\mu\text{m}$  can be achieved by using the command `\SI{2}{\micro\meter}`. In case you need to use the unit for an expression as for example  $20\sin(\omega t) \text{ mA}$ , right after the expression, you can use the command `\si{\milli\ampere}`. 2
- (b) Two resistors of values 1 k $\Omega$  and 4 k $\Omega$  are connected in series across a constant voltage supply of 100 V. A voltmeter having an internal resistance of 12 k $\Omega$  is connected across the 4 k $\Omega$  resistor. Draw the circuit and calculate: 4
- (i) True voltage across 4 k $\Omega$  resistor before the voltmeter was connected.
- (ii) Actual voltage across 4 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 k $\Omega$  resistor.
- (c) If you want to insert a Figure(pdf, png, etc) then you can use the `\includegraphics{nameOfFigure}` command as shown below. : Find the rms value of the current waveform of Fig.1. If the current flows through a 9  $\Omega$  resistor, calculate the average power absorbed by the resistor.

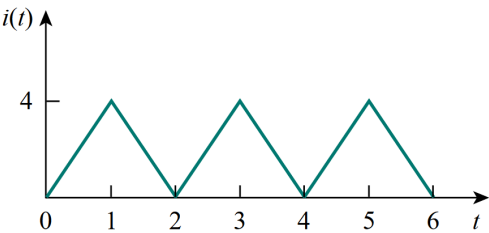


Fig. 1

3. (a) If you want to place two figures side by side then use minipage environment. As for example: Using nodal analysis, determine the potential across the 4  $\Omega$  resistor in Fig. 2 4

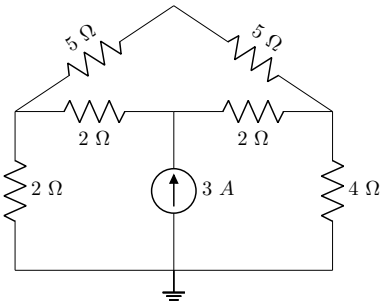


Fig. 2

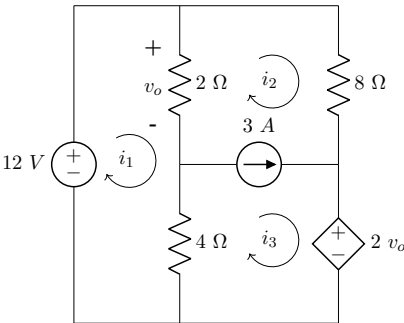


Fig. 3

- (b) Use mess analysis to find currents and voltage  $v_o$  in the circuit of Fig. 3. 4

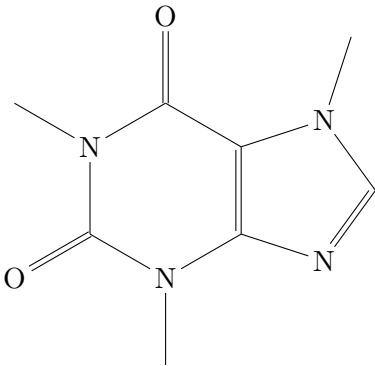
- (c) If a table is needed to insert, then you can use either tabular or tabulrx. In the table as shown in Table 1, the data are given for a general purpose Silicon diode, draw the I-V characteristic curve.2

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) What is photovoltaic device? What is air mass zero (AM0)? What is its value?2
- (b) Suppose a household consumes 500 W of electric power daily over a year. If annual average solar intensity incident per day is about 6 kW h m<sup>−2</sup> and a photovoltaic device that converts solar energy to electrical energy has efficiency of 15%, what is required device area?3
- (c) Draw  $I - V$  characteristics for a photovoltaic device. Define fill factor FF.4+1
- (d) Draw schematic  $I - V$  characteristic of a  $Si$ -solar Cell.2
4. (a) State Fermi’s golden rule using molecular wave function and perturbing Hamiltonian.2
- (b) How does a spin-forbidden transition acquire a finite transition rate?5
- (c) What do you mean by non-radiative transition? Briefly explain internal conversion and intersystem crossing.1+4
5. (a) Using the command `\ce{...}` you can typeset the chemical formula and equations. As for example: Write down whether the given chemical formulas are organic or inorganic.2
- Water: `\ce{H2O}`, H<sub>2</sub>O
  - Benzene: `\ce{C6H6}`, C<sub>6</sub>H<sub>6</sub>
  - Hydrogen peroxide: `\ce{H2O2}`, H<sub>2</sub>O<sub>2</sub>
  - Acetic acid: `\ce{C2H4O2}`, C<sub>2</sub>H<sub>4</sub>O<sub>2</sub>
  - Glucose: `\ce{C6H12O6}`, C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>
- (b) The chemical equation can also be written using the command `\ce{}`. As for example: Explain the following two chemical equations.2+2
- `\ce{2H2 + O2 -> 2H2O}` typesets  $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O}$
  - `\ce{CO2 + C -> 2 CO}` typesets  $\text{CO}_2 + \text{C} \longrightarrow 2\text{CO}$
- (c) Drawing a molecule consists mainly of connecting groups of atoms with lines. Simple linear formulae can be easily drawn using the chemfig package and using the command `\chemfig{*6((=O)-N(-)-(*5(-N=-N(-)-))=-(=O)-N(-)-)}`, as shown in the following example: Identify the given chemical formula.1+4



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:**

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

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

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