

Full marks: 40

Attempt all questions

$$\eta = \frac{P_{\text{output}}}{P_{\text{input}}}$$

Q1. A] Draw a neat schematic and of process steps of nanoimprint lithography (NIL) with a **brief description**. What is the advantage of NIL over photolithography technique? ✓

B] For same tip and surface system two circular nanodots are fabricated. The dwell time for dot 1 is 4 times than that of dot 2. Compare the sizes of the dots. Draw pushing and sliding modes current profiles with STM (no description). ✓ X

[5+1+2+2=10]

Q2. A] Draw I-V characteristics of a PV solar cell in dark and illuminated condition and define **fill factor** and **efficiency** from that. In a schottky barrier type solar cell, why metal-insulator-semiconductor (MIS) interface is better than a metal-semiconductor (MS) interface? Give reason with **appropriate mathematical equation**. ✓ X

B] Draw schematic of a solar cell with metal nanoparticle decoration at the top, illustrating how solar radiation is confined in the active medium. Why the radiation is confined? ✓ [4 + 2 + 4 = 10]

Q3. A] Why a metal semiconductor junction is not practically useful as a base material for spintronic devices? How **diluted magnetic semiconductor** overcome this difficulty? ~~What is the difference between 'carrier mediated exchange interaction and 'bound magnetic polaron' models?~~ ✓

B] For **Magnetic-NM-Magnetic** ultrathin layer, show schematically the conduction of electron as per '**two resistor**' model for parallel and anti parallel cases and show that,

$$GMR = (r_+ + r_-)^2 / 4r_+r_- \quad [5 + 5 = 10]$$

Q4. A] Define '**chiral vector**' for a carbon nanotube. Based on this physical quantity, how CNTs can be classified in three groups? ✓

B] Draw neat sketches of I-V characteristics of **electron field emission** and define 'threshold field. How F-N equation can be used to determine '**field enhancement factor**'? Large number of random nanotubes gives much less current than even few well separated nanotubes. Why? [4 + 2 + 2 + 2 = 10]

(Handwritten notes and scribbles on the right margin, including mathematical symbols like $\frac{1}{2}$ and $\frac{1}{2}$.)