Total No. of Pages: 2

Roll No.....112.....

SECOND SEMESTER

B. Tech. [All Groups]

MID SEMESTER EXAMINATION

March 2016

AP-102: PHYSICS-II

Time: 1.5 Hours

Max. Marks: 30

Note: Attempt *ALL* questions.
Assume suitable missing data, if any.

1.

[a] Consider a particle trapped in an infinite potential box of width a,

$$V(x) = \begin{cases} 0, & 0 < x < a \\ \infty, & otherwise \end{cases}$$

Write the Schrodinger equation for this particle and hence get the expressions for the energy eigen values and energy eigen functions for the particle. Draw its first four energy eigen functions. Find the expectation value $\langle x \rangle$ of the position of the particle. (6)

[b] Show that the operators $\hat{x}$ and $\hat{p}_x$ do not commute. Get the commutator $[\hat{x}, \hat{p}_x]$ and explain its physical significance. (2)

[c] The phase velocity of ocean waves is $\sqrt{\frac{g\lambda}{2\pi}}$, where g is the acceleration of gravity. Find the group velocity of the ocean waves. (2)

2.

[a] X-rays of wavelength 10.0 pm are scattered from a target (i) find the wavelength of the x-rays scattered through 45°. (ii) find the maximum wavelength present in the scattered x-rays. (iii) find the maximum kinetic energy of the recoil electrons. (3)

[b] An electron and a positron are moving side by side in the $+x$ direction at 0.500 c when they annihilate each other. Two photons are produced that move along the x-axis. What is the energy of each photon? (3)

[c] Show that pair production cannot occur in empty space. (2)

3.

[a] Give examples of donor and acceptor type impurities (one each) for Si and GaAs. (2)

[b] A semiconductor at equilibrium has equal electron and hole concentrations of $2 \times 10^8\ cm^{-3}$. On doping with a certain impurity, the hole concentration increases to $4 \times 10^{10}\ cm^{-3}$. Calculate the new electron concentration of the semiconductor. (2)

[c] An abrupt Si p-n junction has $N_A = 10^{18} cm^{-3}$ on one side and $N_D = 5 \times 10^{15} cm^{-3}$ on the other.

(iv) Calculate the contact potential V_0.

(v) Calculate the Fermi level positions at 300K in the p and n regions.

(vi) Draw an equilibrium band diagram for the junction and determine the contact potential V_0 from the diagram. (5)

[d] A bipolar transistor with an emitter current of 1mA has an emitter efficiency of 0.99, and a base transport factor of 0.995. Calculate the base current, the collector current, and the current gain of the transistor. (3)

Use $hc = 1.24 \times 10^{-6}\ eV\,m$, $kT = 0.0259eV$, $q = 1.6 \times 10^{-19}\ Coul$,
$n_i(Si) = 1.5 \times 10^{10}\ cm^{-3}$; $m_0(electron) = 0.511 MeV/c^2$.