REGISTRATION NO.									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

I / II Semester B.Tech. – END SEMESTER EXAMINATION - SEPTEMBER 2021
(MAKE-UP/GRADE IMPROVEMENT)

SUBJECT: ENGINEERING PHYSICS

Duration: 2 hours 01-09-2021 MAXIMUM MARKS: 40

Note: Answer **ANY FOUR full** questions.
Write specific and precise answers. Missing data may suitably be assumed.
Draw neat sketches wherever necessary with axes shown properly.

Planck's constant $h=6.63\times10^{-34}$ Js; speed of light in vacuum $c=3\times10^{8}$ m/s
Density of silver = 10.5×10^{3} Kg/m^3 ; Avagadro's number = 6.023×10^{23}/ mol;
Molar mass of silver is 0.107 Kg/mol ; Mass of electron = 9.1×10^{-31} Kg;
Atomic masses of C and O are 12u and 16u, respectively. $1u=1.67\times10^{-27}$ Kg;

1A. Using a necessary geometry and diagram, obtain an expression for the radii of bright fringes in Newton's rings. [5]

1B. A diffraction pattern is formed on a screen 120 cm away from a 0.400-mm-wide slit. Monochromatic 546.1-nm light is used. Calculate the fractional intensity $\frac{I}{I_{max}}$ at a point on the screen 4.10 mm from the center of the principal maximum. [2]

1C. If the spacing between planes of atoms in a NaCl crystal is 0.281 nm, what is the predicted angle at which 0.140-nm x-rays are diffracted in a first-order maximum? Calculate the angle of incidence of the x-ray beam. [3]

2A. Using the energy and momentum conservation, derive an expression for the wavelength of the scattered photon (λ') in Compton effect experiment. [5]

2B. Un polarized light is incident upon two polarizers that have their polarization axes at an angle of 45^o. If the incident intensity is I_o, what is the final intensity? [2]

2C. An electron is confined between two impenetrable walls 0.20 nm apart. Determine its

energy, momentum and de Broglie wavelength in the ground state. [3]

3A. Explain three types of transitions between two energy levels, when radiation interacts with matter. [3]

3B. A quantum simple harmonic oscillator consists of an electron bound by a restoring force proportional to its position relative to a certain equilibrium point. The proportionality constant is 8.99 N/m. What is the longest wavelength of light that can excite the oscillator? [3]

3C. Explain photoelectric effect. Which are the features of photoelectric effect-experiment explained by Einstein's photoelectric equation? [4]

4A. Assuming the Fermi-Dirac distribution function , obtain an expression for the density of free-electrons in a metal with Fermi energy E_F, at zero K and, hence obtain expression for Fermi energy E_F in a metal at zero K. Given: density-of-states function

$$g(E)\,dE = \frac{8\sqrt{2}\,\pi\, m^{3/2}}{h^3} E^{1/2}\,dE$$

[4]

4B. The wave function for H-atom in ground state is

$$\psi_{1s}(r) = \frac{1}{\sqrt{\pi a_o^3}} e^{-\frac{r}{a_o}}$$

Obtain an expression for the radial probability density of H-atom in ground state. Sketch schematically the plot of probability density of H atom in the ground and 2s state vs. radial distance. [3]

4C. Silver is a monovalent metal. Calculate (a) Fermi energy (b) Fermi speed and (c) the de Broglie wavelength corresponding to the Fermi speed. [3]

5A. With necessary diagrams, explain doping in semiconductors. [4]

5B. The frequency of photon that causes v = 0 to v = 1 transition in the CO molecule is 6.42 x 10^{13} Hz. Ignore any changes in the rotational energy. (A) Calculate the force constant k for this molecule. (B) What is the maximum classical amplitude of vibration for this molecule in the v = 0 vibrational state ? [3]

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5C. A bismuth target is struck by electrons, and x-rays are emitted. Estimate (a) the M- to L-shell transitional energy for bismuth and (b) the wavelength of the x-ray emitted when an electron falls from the M shell to the L shell. [3]

Atomic number of bismuth=83

6A. Explain briefly the BCS theory of superconductivity in metals. Why all conductors are not superconductors? [3]

6B. Obtain an expression for rotational energy of a diatomic molecule. Sketch schematically these rotational energy levels. [4]

6C. A cobalt target is bombarded with electrons, and the wavelengths of its characteristic x-ray spectrum are measured. A second, fainter characteristic spectrum is also found, due to an impurity in the target. The wavelengths of the K_α lines are 178.9 pm (cobalt) and 143.5 pm (impurity). What is the impurity ? Atomic number of Cobalt is 27 [3]

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