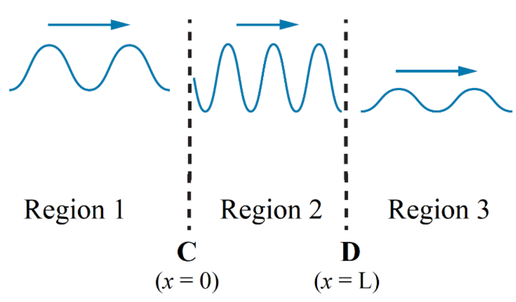
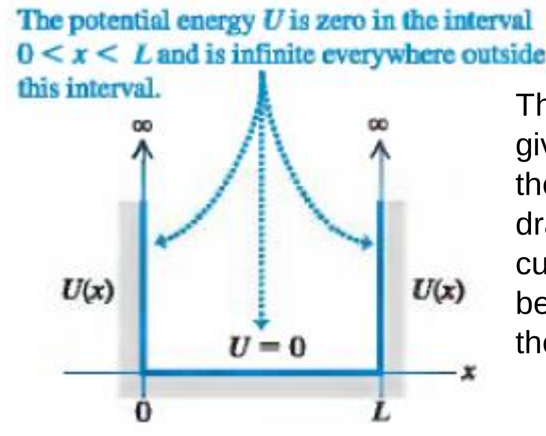
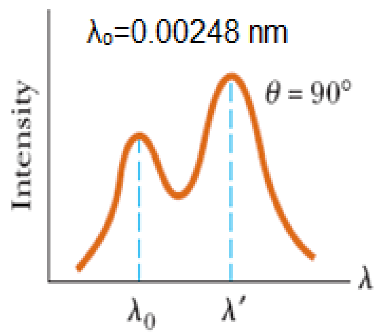
MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

II SEMESTER B. TECH (PHYSICS)
IN SEMESTER EXAMINATION – II, JUNE 2020
SUBJECT: ENGINEERING PHYSICS (PHY 1051)
REVISED CREDIT SYSTEM

Time: 90 Minutes **MAX. MARKS: 15**

Note: Answer ALL the questions.
Upload a single pdf file in MS Teams

1.	Explain all the laws governing the blackbody radiation.	**03**
2.	Prove the uncertainty relation for energy (E) and time (t) i.e., $\Delta E.\Delta t \geq \frac{h}{4\pi}$ from position (x) –momentum (p) uncertainty relation $\Delta x.\Delta p \geq \frac{h}{4\pi}$.	**02**
3.	Consider a particle subject to a linear restoring force $F=-kx$, where k is a constant and x is the position of the particle relative to equilibrium (x=0). Classically, if the particle is displaced from its equilibrium position and released, it oscillates between the points $x=-A$ and $x=+A$, where A is the amplitude of the motion. Derive an expression for the total energy of the oscillator. Take x=Asinωt	**02**
4.	A free particle moving along positive x-axis encounter three regions as shown in the figure. The wave functions of the particle in region 1 and region 2 are of the form $\Psi(x) = A\sin(kx-\omega t)$. Where $k=2\pi/\lambda$ is a wave number and $\omega t = \phi$ is the phase term. In region 1, the amplitude of the wave function A_1=11.5, wavelength λ_1 = 4.97 nm and phase $\phi_1 = -65.3^o$. The wavelength in region 2 is λ_2 = 10.5 nm. The boundary C is located at x = 0, and the boundary D is located at $x = L$, where L = 20 nm. Using the mathematical features of wave function, find the amplitude of the wave function and the phase in region 2. (A_2 and ϕ_2) 	**03**

5.	 The potential energy versus distance plot is given in the diagram. Assuming an electron in the potential box in its second excited state, draw the probability density versus distance curve. Find the probability of finding the electron between adjacent nodes. Exclude the nodes at the boundary.	**02**
6.	 Assuming a photon- free electron scattering in Compton effect, calculate the momentum of incident photon, scattered photon and recoiling electron. Find the angle through which the electrons are scattered. Planck's constant=$6.63\text{x}10^{-34}$ Js; Mass of electron = $9.1\text{x}10^{-31}$ Kg ; Speed of light in vacuum = $3.0\text{x}10^{8}$ m/s	**03**

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HAND BOOK FOR STUDENTS

Quantum Physics		
Wien's Displacement Law	$\lambda_m T = 2.898 \times 10^{-3}$ m.K	λ_m: wavelength corresponding to peak intensity. T : equilibrium temperature of the blackbody.
Stefan's Law	$P = \sigma A\ e\ T^4$	P : power radiated from the surface area A of the object. T : equilibrium surface temperature. σ : Stefan-Boltzmann constant. e : emissivity of the surface
Planck's law	$I(\lambda, T) = \frac{2\pi hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda k_B T}} - 1}$	$I(\lambda, T)\ d\lambda$: intensity or power per unit area emitted in the wavelength interval $d\lambda$ from a blackbody at the equilibrium temperature T h : Planck's constant. k_B : Boltzmann's constant c : speed of light in vacuum
Einstein's photoelectric equation	$K_{max} = hf - \phi$	f : frequency of incident photon. K_{max} :kinetic energy of the most energetic photoelectron. ϕ : work function of the photocathode material.

Relativistic momentum of a particle	$p = \gamma\, m\, v$ $\gamma = \dfrac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$	p : momentum of the particle m : mass of the particle v : speed of the particle c : speed of light in vacuum
Relativistic kinetic energy of a particle	$K = (\gamma - 1)\, m\, c^2$	
Total energy (relativistic) of the particle	$E = \gamma\, m\, c^2$ $E^2 = p^2 c^2 + m^2 c^4$	
Compton shift equation	$\lambda' - \lambda_o = \dfrac{h}{mc}(1 - \cos\theta)$	λ_o : wavelength of the incident photon. λ' : wavelength of the scattered photon, θ : angle of scattering
de Broglie wavelength, λ	$\lambda = \dfrac{h}{p} = \dfrac{h}{mv}$ $p = m\,v = \sqrt{2\, m\, q\, \Delta V}$	h : Planck's constant p : momentum of the quantum particle. m : mass of the particle v : speed of the particle q : charge of the particle ΔV : accelerating voltage
Relation between group speed and phase speed	$v_g = v_P - \lambda\left(\dfrac{dv_P}{d\lambda}\right)$	v_g : group speed v_P : phase speed
Heisenberg uncertainty relations.	$(\Delta x)\,(\Delta p_x) \geq h / 4\pi$ $(\Delta E)\,(\Delta t) \geq h / 4\pi$	Δx : uncertainty in the measurement of position x of the particle. Δp_x : uncertainty in the measurement of momentum p_x of the particle. ΔE : uncertainty in the measurement of energy E Δt : time interval in the measurement of E.
	Quantum Mechanics	
One dimensional time independent Schrödinger equation	$-\dfrac{\hbar^2}{2\,m}\dfrac{d^2\psi}{dx^2} + U\,\psi = E\,\psi$	$\hbar$: Reduced Planck's constant m : mass of the particle ψ : *wave function* $U(x)$: potential energy function E : total energy of the system h : Planck's constant L : length of the "box". n : integers T : tunneling probability
Wave function for a particle inside a potential box	$\psi_n(x) = \sqrt{\dfrac{2}{L}}\, \sin\left(\dfrac{n\,\pi\, x}{L}\right)$	
Particle in a "box" E_n - quantized energy values of the particle.	$E_n = \left(\dfrac{h^2}{8\, m\, L^2}\right) n^2$	
Transmission coefficient	$T \approx e^{-2CL}$ $C = \dfrac{\sqrt{2\, m\,(U - E)}}{\hbar}$	