Detail of COs, BL and PIs

Course Outcome (CO)
1. Knowledge of multiphysics to understand engineering problems
2. Skills to use logic towards engineering problems with multiphysics implementation.
3. Ability to use modern engineering physics techniques and tools.
4. Solve engineering problems with the knowledge of basic and applied physics.

Bloom's Taxonomy Levels (BL): 1-Remembering, 2-Understanding, 3-Applying, 4-Analyzing, 5-Evaluating, 6-Creating

Unit	Remember (1)		Understand (2)		Apply (3)			Analyzing (4)	Evaluate (5)	Create (6)	
	Recall	Label	Prove	Explain	Use	Develop	Find	Compare	Calculate	Build	Tot.
I	-	-	7	-	7	7	-	-	-	-	21
II	-	-	-	-	7	-	-	7	7	-	21
III	-	-	-	7	-	7	-	-	-	-	14
IV	-	7	7	-	-	-	7	-	7	-	28
V	7	-	-	-	-	-	7	7	-	-	21
Tot.	14		21		42			14	14	0	105

Table 1: **Table of specifications (TOS) for the allocation of Bloom's taxonomy levels**

Program Outcomes (POs)		Performance Indicator (PI)
Engineering knowledge	**1.2.1**	Apply laws of natural science to an engineering problem
	1.3.1	Apply fundamental physics concepts to solve engineering problems
Problem analysis	**2.1.2**	Identify systems, variables, and parameters to solve the problems
	2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
	2.2.4	Compare and contrast alternative solution processes to select the best process.
	2.3.1	Combine scientific principles and engineering concepts to formulate mathematical models of a system or process that is appropriate in terms of applicability and required accuracy.
	2.3.2	Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
Design / Development of Solutions	**3.3.1**	Apply formal decision making tools to select optimal solutions for further development
Conduct investigations of complex problems	**4.1.3**	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
Modern tool usage	**5.2.1**	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.

Table 2: **List of program outcomes and the relevant performance indicators**

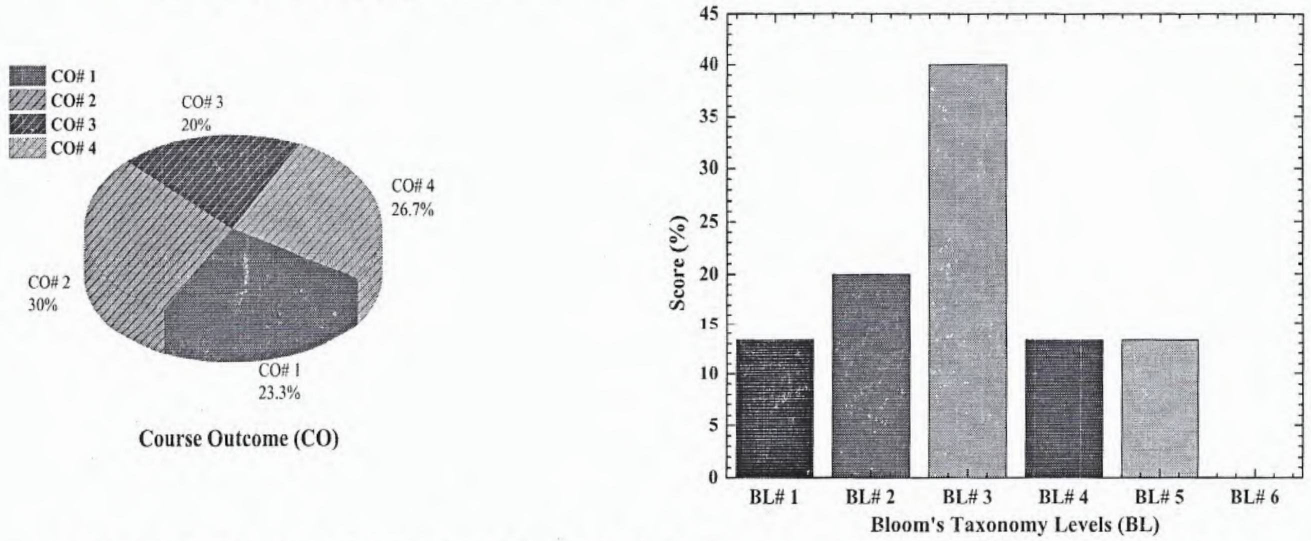

Figure-2: Mapping of COs and BLs with the score covered by the respective questions.

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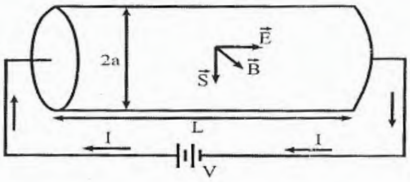
B.E. (All BRANCHES)

PH10006 / PH10002 : PHYSICS

Time: 180 min | Total Number of Questions: 5 | Max. Marks: 70

NOTE: ***Attempt any*** **TWO** ***part of each question. Each part carry 7 marks.***

Questions	CO	BL	PI
1a.- State Poynting theorem. With the help the given figure drive the expression for energy per unit time ($\vec{S}$) passing through the surface of the wire. Symbols have their usual meanings. **(03+04)**  	1,4	3	2.1.2
1b.- Prove the following **(i)** Electromagnetic wave have transverse nature. **(02)** **(ii)** $x^2 + y^2 + z^2 = c^2t^2$ is invariant under Lorentz transformation. **(03)** **(iii)** Velocity of light in free space $= 1/\sqrt{\mu_o \epsilon_o}$ (Hint: Use Maxwell's equation) **(02)**	2,4	2	1.3.1
1c.- State fundamental postulates of special theory of relativity and deduce Lorentz transformation of space and time. **(03+04)**	3,4	3	1.3.1
2a.- Explain the theory of plane transmission grating for gating nth order maxima. Also, compare the diffraction pattern of grating with that of a single slit. **(05+02)**	1,2	4	2.2.4
2b.- Define resolving power, limit of resolution, Rayleigh criteria and calculate the **(03)** **(ii)** angular position of 4^{th} order maxima, if for the normal illumination of a transmission grating, the first order diffraction maxima is at 12^o. **(02)** **(iii)** diameter of a telescope lens, if at 600nm the required resolution is $0.1''$. **(02)**	3,4	5	2.3.1
2c.- For sustained interference we need two coherent sources. With the help of necessary theory and diagram demonstrate the application of interference in laboratory. However you have a sodium vapor lamp. **(07)**	1,4	3	4.1.3
3a.- Discuss Heisenberg uncertainty principle and explain the following. **(03)** **(i)** Quantization of energy level of an atom. **(02)** **(ii)** Non existence of electron in nucleus. **(02)**	1,2	2	1.2.1
3b.- What is Compton effect ? Why the effect is significant only for microscopic particles ? Develop the expression for Compton shift and angle of recoil. **(01+01+05)**	1,2	3	2.3.2
3c.- Deduce eigenfunction and eigenvalues of an electron in a deep potential well of width L. Find the probability of finding the electron in first exited state between 0.45L and 0.55L of the well. **(04+03)**	2,4	5	2.3.1
4a.- Prove that, being the negative temperature state, the population inversion can be achieved at room temperature. Why the two level lasing is not possible ? **(04+03)**	2,3	2	1.2.1
4b.- Draw energy level transitions in He-Ne laser showing values of each level and lasing wavelengths. Also, for selective wavelength lasing, discuss the significance of He:Ne ratio, tube diameter and length of the optical cavity. **(03+04)**	2,3	1	2.1.3
4c.- Describe the construction and working of ruby laser. What is the main drawback of ruby laser ? Calculate the number of photon per pulse of ruby laser that emits pulses of 0.15 J for 12 ps and emits light of wavelength 694.4 nm. **(04+01+02)**	2,4	3	2.1.2
5a.- Briefly describe intermodal and intramodal dispersion in optical fiber. Drive the expression for total time delay due to modal dispersion in step index fiber. **(03+04)**	1,3	4	3.3.1
5b.- In optical fiber, why cladding is required? If the cut-off angle for light entering a step index fiber ($n_{core} = 1.425$) from air is 8.50^o find the values of **(02)** **(i)** Numerical aperture (NA), fractional refractive index and n_{clad} of the fiber ? **(03)** **(ii)** How the value of these parameter changes when fiber submersed in water ? **(02)**	1,4	3	2.1.2
5c.- Explain the terms normalized frequency, numerical aperture, acceptance angle and fiber optic communication system. On the basis of mode of fiber and type of index, which fiber will you prefer for long distance communication and why ? **(04+03)**	2,3	1	5.2.1

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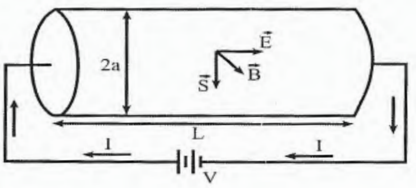
1a.- State Poynting theorem. With the help the given figure drive the expression for energy per unit time ($\vec{S}$) passing through the surface of the wire. Symbols have their usual meanings. (03+04) 	1,4	3	2.1.2
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As. 1a Electric field ∥ to the wire is $E = \frac{V}{L}$

Circumferencial magnetic field at the surface of wire $B = \frac{\mu_0 I}{2\pi a}$

Magnitude of poynting vector $S = -\frac{1}{\mu_0}\frac{V}{L}\cdot\frac{\mu_0 I}{2\pi a} = \frac{VI}{2\pi a L}$

Energy per unit time passing through the surface of the wire is

$$W = \int S\cdot da = S(2\pi a L) = VI$$

$$\boxed{W = VI}$$

Ans. 1b. (i) prove $\vec{E}\cdot\vec{B} = \vec{B}\cdot\vec{k} = \vec{k}\cdot\vec{E} = 0$ (Page 10.21, Malik & Singh, Engg Phys)

(ii) prove $x'^2+y'^2+z'^2-c^2t'^2 = x^2+y^2+z^2-c^2t^2$; $t'=\gamma t$

$x' = \gamma(x+vt)$; $y'=\gamma(y+vt)$; $z'=\gamma(z+vt)$;

$t'=\gamma(t-xv/c^2)$

iii) $\vec{k}\times\vec{H} = -\omega\epsilon_0\vec{E} \Rightarrow \vec{k}(\vec{k}\cdot\vec{E}) - k^2\vec{E} = \omega\mu_0[-\omega\epsilon_0\vec{E}]$

$$\Rightarrow (k^2-\omega^2\mu_0\epsilon_0)\vec{E}=0$$

$$\Rightarrow \frac{k^2}{\omega^2} = \mu_0\epsilon_0 \Rightarrow \frac{\omega}{k} = \frac{1}{\sqrt{\epsilon_0\mu_0}}$$

$$\Rightarrow \boxed{c = \frac{1}{\sqrt{\epsilon_0\mu_0}}}$$

Ans-1a Page No. 10.31 eqn 10 $\int \vec{E}\cdot\vec{J}\,dV = -\frac{\partial}{\partial t}\int_V[\frac{1}{2}\mu H^2+\frac{1}{2}\epsilon E^2]\,dV - \int_S(\vec{E}\times\vec{H})\cdot d\vec{S}$

Interpretation of each component of this eqn. (Malik & Singh, Engg Phys)

Ans-1c Page 11.7, article 11.5 & 11.6 (Malik & Singh, Engg Phys)

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2c.- For sustained interference we need two coherent sources. With the help of necessary theory and diagram demonstrate the application of interference in laboratory. However you have a sodium vapor lamp. (07)	1,4	3	4.1.3

2a.) 5 marks for derivation of $N(e+d)\sin\theta = \pm m\lambda$

2 marks for ploting and comparing two diff. pattern as shown below

2b. for transmission gratting $\sin\theta \propto m$

ii) given $\sin 12 \propto 1$, $\sin\theta \propto 4$ $\Rightarrow \frac{\sin 12}{\sin\theta} = \frac{1}{m} = \frac{1}{4}$

$\Rightarrow$ $m \neq$ $\sin\theta = 4\sin 12 \Rightarrow \boxed{\theta = 56.3^0}$

iii) limit of resolution θ is given by

$\theta = \frac{1.22\lambda}{a} \Rightarrow a = \frac{1.22\lambda}{\theta} = \frac{1.22 \times 600 \times 10^{-9}}{.485 \times 10^{-6}} m$

$\left(\because 1\ sec. = 4.85 \times 10^{-6} Rad.\right)$ $\boxed{a = 1.51\ m}$

$\left(or\ 1'' = \frac{\pi}{180} \times \frac{1}{60 \times 60} Rad\right)$

2C. Explanation of newton's Ring experiment with diagram showing wadge shaped thin film interference over the boundry of air film created b/w glass plate & curved surface of lense.

Also derivation of $\boxed{\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}}$

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3a. (i) Discussion about the Bhor's model. $mvr = n\hbar$

(ii) Claculation of energy of e^- emiting from nucleous and compair it with obtained energy of emiting particle.

3b. Article 14.8. on page 14.11 (Malik & Singh, Engn. Phys)

3c. Wave fun^n of particle in a deep potential well

$$\psi_n = \sqrt{\frac{2}{L}} \sin\frac{n\pi x}{L}$$

for ground state $n = 1$

" first exited state $n = 2$

Thus probablity in Ist exited state is

$$P = \int_{0.45L}^{0.55L} |\psi_2|^2 dx$$

$$= \int_{0.45L}^{0.55L} \frac{2}{L}\sin^2\frac{2\pi x}{L}dx = \frac{1}{L}\int_{0.45L}^{0.55L}\left(1-\cos\frac{4\pi x}{L}\right)dx$$

$$= \frac{1}{L}\left[x - \frac{\sin 4\pi x/L}{4\pi x/L}\right]_{0.45L}^{0.55L}$$

$$= \frac{1}{L}\left[0.10L - \left(\frac{\sin 2.2\pi}{2.2\pi} - \frac{\sin 1.8\pi}{1.8\pi}\right)\right]$$

$$= \frac{1}{L}\left[0.10L - \frac{1}{\pi}(0.546 - 0.546)\right] = 0.10$$

$$\boxed{P = 0.10}$$

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4c. Energy emited by ruby laser = 0.15 J

if n be no of photon is n then $nh\nu = 0.15$ J

$$n = \frac{0.15}{h\nu} = \frac{0.15 \times \lambda}{h \times c}$$

$$n = \frac{0.15 \times 694.4 \times 10^{-9}}{6.6 \times 10^{-34} \times 3 \times 10^{8}} = 5.26 \times 10^{17}$$

$$\boxed{n = 5.26 \times 10^{-17}}$$

4a. $\frac{N_2}{N_1} = e^{\frac{-(E_2-E_1)}{kT}} = e^{-h\nu/kT}$ for $N_2 > N_1$ $T < 0$

i.e. population inversion is supposed to be the negative temp state. But due to the meta-stable energy state having comparativly large life time ($\sim 10^{-3}$ s) the Condition of population inversion can be achived at room temp.

Two level lasing is not possible because condition of population inversion can not be achived in two levels only. If it is so than it violets the uncertanity principal of Energy and time i.e. $\Delta E \Delta t \geq \hbar$

4b. Explain the working of He-Ne Laser, with the help of schachmatic diagram of laser system. Its energy levels

Selective wavelength lasing can be achived by changing He:Ne gas ratio or by changing the length of the cavity.

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5a. Derivation of $\Delta t = \frac{n_1 L}{c}\left[\frac{n_1}{n_2} - 1\right]$

$$= \frac{n_1 L}{c}\left[\frac{\Delta}{1-\Delta}\right]$$

or $\Delta t = \frac{L}{2n_2 c}(NA)^2$

n_1 = R.I. of core
n_2 = R.I. of cladding.
L = Length of fiber
$\Delta = \frac{n_1 - n_2}{n_1}$

5b (i) Cut-off angle $= \theta_{max} = 8.50^0$

$NA = \sin\theta_{max} = 0.15$ $\boxed{NA = 0.15}$

$NA = \sqrt{n_1^2 - n_2^2} \Rightarrow (NA)^2 = n_1^2 - n_2^2 \Rightarrow n_2^2 = n_1^2 - (NA)^2$

$n_2^2 = (1.452)^2 - (\sin 8.5)^2 = 2.08$

$\Rightarrow \boxed{n_2 = 1.444} = n_{clad}$

$\Delta = \frac{n_1 - n_2}{n_1} = \frac{1.452 - 1.444}{1.452} = 5.5\times10^{-3}$

$\boxed{\Delta = .0055}$

(ii) when fiber is submerged in water of r.i. n_0

The N.A. $= n_0 \sin\theta_{max} = \sqrt{n_1^2 - n_2^2}$

Accordingly NA will increases and hence n_{clad} decreases. also Δ increases.