



UNIVERSITY OF TORONTO

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**UTSC
(SEM II) THEORY EXAMINATION 2021-22
PHYSICS**

Time: 3 Hours

Full Marks: 100

Notes:

- Attempt all Sections and Answer any missing data.
- Appropriate marks are allotted to each question, answer accordingly.

SECTION-A	Attempt ALL of the following Questions in brief	Marks(10X10=100)	CO
Q1(a)	State Einstein's postulates of special theory of relativity.	2	1
Q1(b)	State that the maximum of a graph is zero.	1	1
Q1(c)	State Newton's law of motion.	1	1
Q1(d)	Define thin lens.	1	1
Q1(e)	What is work done against?	1	1
Q1(f)	What is wave function?	1	1
Q1(g)	What are coherent sources?	1	1
Q1(h)	Explain Fermi's and Fermi-Dirac's distribution.	1	1
Q1(i)	What are the steps for determining and designing an optical fibre?	3	1
Q1(j)	What are the main components of laser?	3	1

SECTION-B	Attempt ANY THREE of the following Questions	Marks(10X10=100)	CO
Q2(a)	What is length contraction? Derive the necessary expressions for $L = L_0 \sqrt{1 - v^2/c^2}$ and $t = \gamma t_0$ (where $\gamma = 1/\sqrt{1 - v^2/c^2}$) in terms of Lorentz transformation.	10	1
Q2(b)	What is displacement current? For a parallel plate capacitor, conductivity is $\sigma = 10 \times 10^7$ ohm ⁻¹ m, $\epsilon_0 = 8.85 \times 10^{-12}$ F/m. Find the displacement and displacement current densities if the magnitude of electric field density is given by $E = 100 \sin(2\pi \times 10^8 t)$ V/m.	10	2
Q2(c)	What is the de Broglie hypothesis? Find the least energy of an electron moving in one dimension in an infinitely high potential box of width 1×10^{-10} m. (Mass of electron is 9.1×10^{-31} kg and $h = 6.63 \times 10^{-34}$ J.s)	10	3
Q2(d)	Explain interference in thin film and prove that reflection and transmission are complementary with each other.	10	4
Q2(e)	Derive the expressions for acceptance angle and numerical aperture of an optical fibre.	10	3

SECTION-C	Attempt ANY ONE following Question	Marks (10X10=100)	CO
Q3(a)	By using Lorentz transformation equations, derive time dilation. Show that time dilated is a real effect.	10	1
Q3(b)	Discuss and derive the relativistic velocity addition formula. Show that it is equivalent with Einstein's second postulate. Show that $E^2 - P^2 c^2 = m_0^2 c^4$, Where P is the momentum.	10	1

SECTION-C	Attempt ANY ONE following Question	Marks (10X10=100)	CO
Q4(a)	Derive electromagnetic wave equation in free space and prove that electromagnetic waves travel with speed of light in free space.	10	2
Q4(b)	Derive the Poynting or energy current for the plane wave in an electromagnetic field. Also give the physical interpretation.	10	2

SECTION-C	Attempt ANY ONE following Question	Marks (10X10=100)	CO
Q5(a)	Give the physical significance of wave function. Derive Schrodinger's time independent wave equation.	10	2
Q5(b)	Derive Compton effect and derive an expression for the Compton shift (20).	10	3

SECTION-C	Attempt ANY ONE following Question	Marks (10X10=100)	CO
Q6(a)	Explain and describe the formation of Newton's class in reflected light. Prove that in reflected the formation of dark class are perpendicular to the system axis of several colours.	10	4
Q6(b)	Discuss class of Fermi-Dirac's distribution and show that the relative likelihood of successive transitions are nearly 1: 5/2 : 1/2 : 1/121.....	10	4

SECTION-C	Attempt ANY ONE following Question	Marks (10X10=100)	CO
Q7(a)	With the help of diagram classify and describe various types of optical fibres based on their end use and refractive index.	10	5
Q7(b)	Draw a semi diagram of fibre for laser and explain the mechanism and working of it.	10	5