VIT®

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Continuous Assessment Test (CAT - I), February 2024					
Programme	:	**B. Tech**	Semester	:	**Winter 2023-2024**
Course Title	:	**Engineering Physics**	Course Code	:	**BPHY101L**
School	:	**School of Advanced Sciences**	Slot	:	**D2+TD2**
Duration	:	**90 mins**	Max. Marks	:	**50**
Class No	:	**1914, 1906, 1910, 1912, 1916, 1903, 1905, 1915, 1913, 1911, 1908**			

Part – A (5 x 10 = 50)

Answer ALL Questions

Sl. No	Questions	Max Marks
1	What is a transverse wave? Explain with an example. With a clear diagram and assumptions, derive the equation for the wave propagating on a string of linear mass density μ and under a tension T.	10
2	Derive the expression for displacement, wavelength, and frequency of n^{th} mode of a standing wave on a string of length L fixed at two ends. Draw the wave patterns for the second and fifth harmonics.	10
3	(a) What is the characteristic impedance of a string? With suitable diagrams, discuss what happens when a wave on a string is reflected by a (i) free end and (ii) fixed end. (b) A wave travels through a junction between two strings of different linear mass densities. The linear mass density of the first medium is 0.1 gcm^{-1} and that of the second medium is 1 gcm^{-1}. Compute the reflection and transmission coefficients of the wave.	5 5
4	Starting from the differential form of Maxwell's equations, derive the wave equations for electric and magnetic fields in free space. Further, detail how Maxwell concluded that the light must be an electromagnetic wave.	10
5	(a) Consider the vector field $\vec{F}=x e^{y}\hat{i}+y e^{z}\hat{j}+z e^{x}\hat{k}$. Compute the *curl* and the *divergence of curl* of the vector field, showing all the intermediate steps. (b) Explain the construction and working of the Hertz experiment.	5 5

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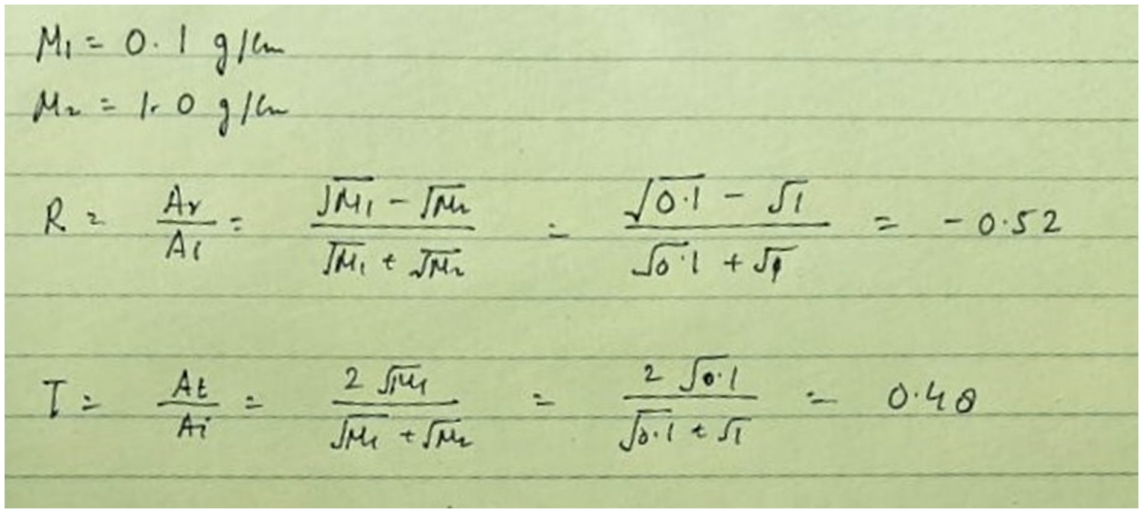
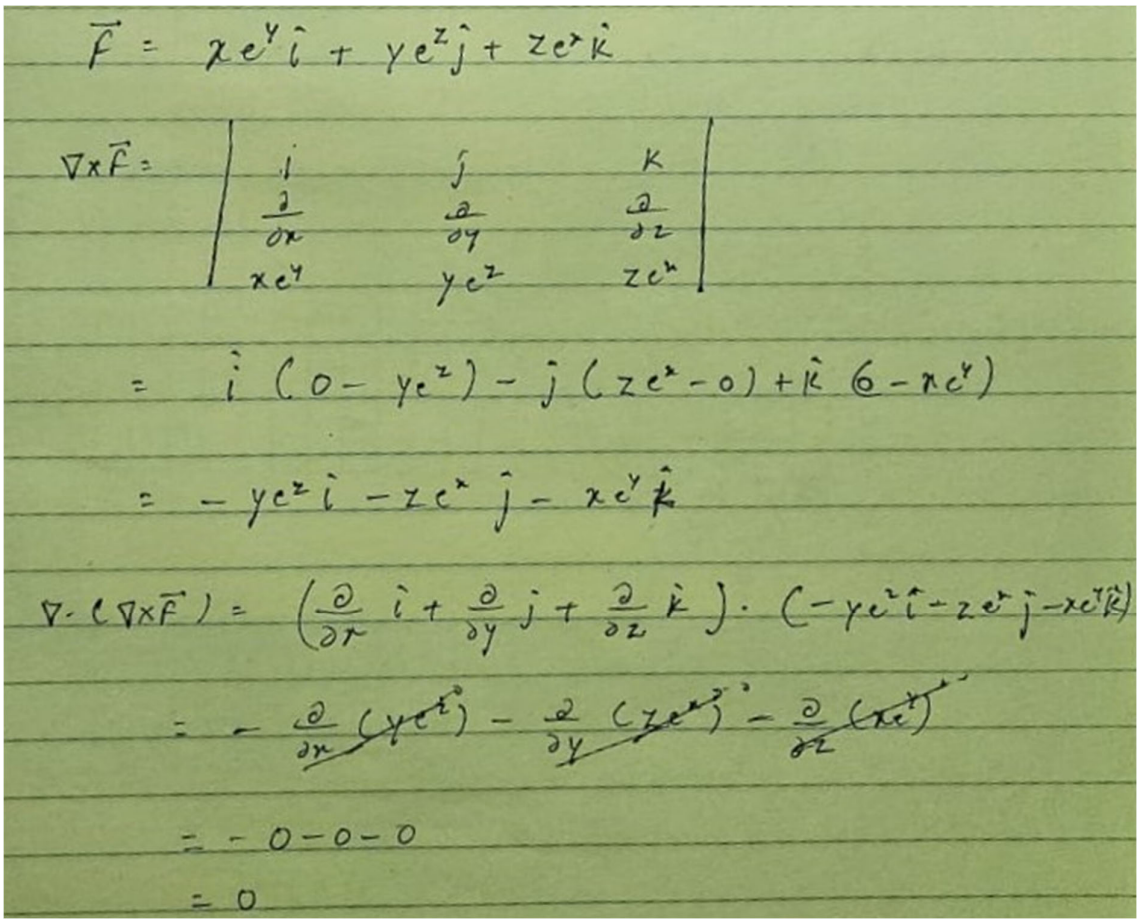
Answer Key

Sl. No	Questions		Max Marks
1	Definition of transverse wave and example	2 marks	**10**
	Derivation of wave equation		
	Labelled diagram	2 marks	
	Assumptions	2 marks	
	Derivation	4 marks	
2	Derivation of displacement of standing wave	4 marks	**10**
	Eigenfreqeuncy and wavelength expression:	4 marks	
	Standing wave pattern for second and fifth harmonic:	2 marks	
3	(a) Definition of characteristic impedance	1 mark	**5**
	(i) discussion of wave reflection at a free end (with diagram)	2 marks	
	(ii) discussion of wave reflection at a fixed end (with diagram)	2 marks	
	(b) Formulae for reflection (R) and transmission (T) coefficients	2 marks	**5**
	Calculation and results	3 marks	



Reflection coefficient = -0.52 Transmission coefficient = 0.48

4	Maxwell's equations in free space 2 marks Wave equation derivation for electric field 3 marks Wave equation derivation for magnetic field 3 marks EM wave speed calculation and comparing it with the speed of light 2 marks	**10**
5	(a) Compute the curl of the vector field (show all the steps) 3 marks Compute the divergence of curl of the vector field (show all the steps) 2 marks  (b) Hertz experiment – components 2.5 marks Hertz experiment – working 2.5 marks	**5**