33031

SEM-II	F. Y. B. Sc PHYSICS – II	100 MARKS 3 HRS

Note: 1) All questions are compulsory.
2) Use of non- programmable calculator is allowed.
3) Draw figures wherever necessary.
4) Symbols have their usual meanings unless mentioned.

Q.1	(A)	Select the correct option	12
	i)	If div $\vec{V}$ =0 ,then $\vec{V}$ is called as ____________ (a) solenoidal vector	
	ii)	If $\vec{A} = \hat{i} - \hat{j} + \hat{k}$ and $\vec{B} = \hat{i} + 2\hat{j} - \hat{k}$, then $\vec{A}.\vec{B}$ = __________ (c) -2	
	iii)	The degree and order of differential equation. $\frac{d^2y}{dx^2} + 16y = 0$ *is* ______. (a) 1,2	
	iv)	An inductance of 2H and a resistance of 4Ω are connected in series with a D.C. source of 4V. The time constant of the circuit is _____________. (a)0.5 sec.	
	v)	The wave which propagates through a medium in which the particle vibrate perpendicular to the direction of propagation is called as ___________. (a) Transverse wave	
	vi)	A particle is subjected to two perpendicular S.H.Ms, having different amplitude with periods in the ratio of 1:2, and with phase difference δ=0. The path traced by the particle is------ (a) A figure of eight	
	(B)	Answer in one sentence :	03
	i)	Define Scalar field. Scalar field is a function of space that associates a real number or scalar with every position in space.	
	ii)	Define time constant of a LR circuit. Definition 1 mark	
	iii)	Define group velocity. Number of waves of different frequencies, wavelengths and velocities are superimposed to form a group of waves or wave packets. The motion of such wave packet is described as group velocity.	

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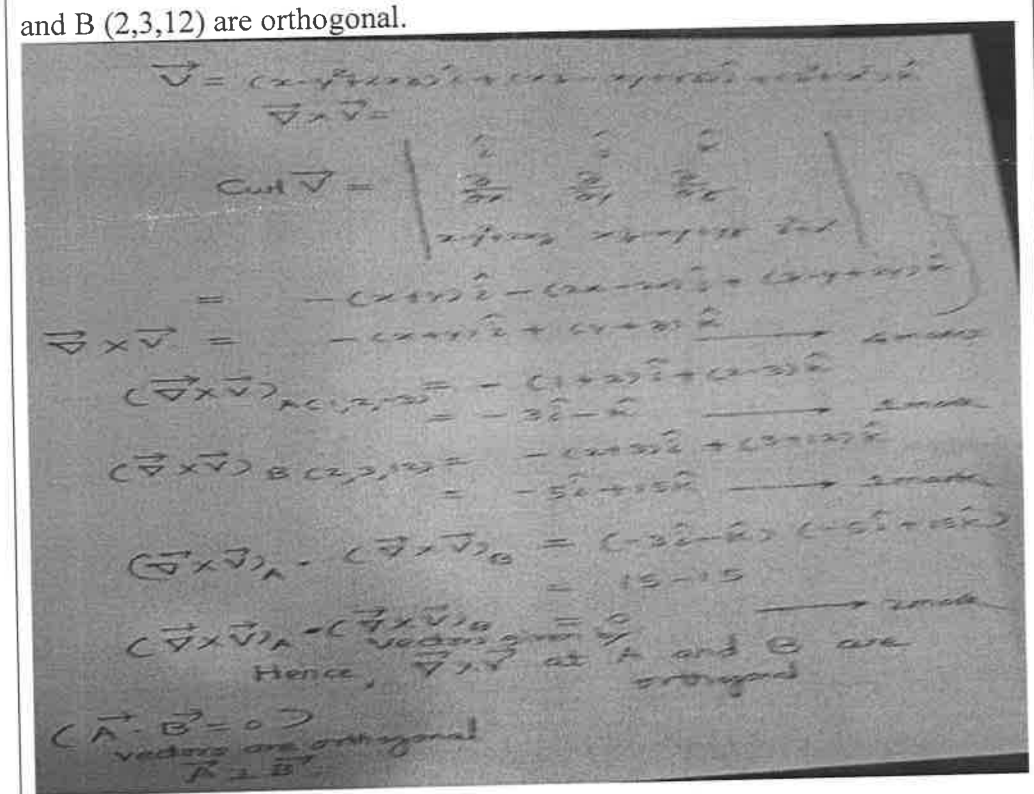
	(C)	Fill in the blanks	
	i)	Acceleration is Vector quantity.	
	ii)	The vector differential operator Del is defined in Cartesian coordinates as . $\frac{\partial}{\partial x}\hat{\imath} + \frac{\partial}{\partial y}\hat{\jmath} + \frac{\partial}{\partial z}\hat{k}$	
	iii)	Ordinary differential equation contains one independent variable.	
	iv)	In series LCR circuit, the charging of the capacitor under the condition $R^2/4L^2=1/LC$ is called as critically damped.	
	v)	Waves transmit Energy from one place to another.	
			08
Q.2	(A)	Attempt any one	
	i)	Define divergence of a vector field. Explain the Physical significance of divergence of a field with the help of suitable examples.. Definition of divergence of vector field (2 marks) Physical significance of divergence – 4 marks; Examples 2 marks.	
	ii)	Prove that $\vec{i}\times(\vec{A}\times\vec{i}) + \vec{j}\times(\vec{A}\times\vec{j}) + \vec{k}\times(\vec{A}\times\vec{k}) = 2\vec{A}$ 1.Vector A in component form 1 marks 2. Substitution--2 marks 3. Simplify-3 marks 4. answer -2marks	
			08
	(B)	Attempt any one	
	i)	What is gradient of a scalar field? Obtain the directional derivative at (1,2,3) of $\emptyset = xy + yz + zx$ in the direction of vector $3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}$. Gradient of a scalar function is a vector such that its magnitude is equal to maximum rate of change of the scalar function at a point in the region and its direction is perpendicular to the surface of the scalar function. If $\varphi = \varphi(x,y,z)$ is a scalar function then grad $\varphi = \nabla\emptyset$ 3 marks Solve $\nabla\emptyset_{(1,2,3)} = 5\hat{\imath} + 4\hat{\jmath} + 3\hat{k}$ 2 marks	

		Unit vector in the direction of $3\hat{\imath} + 4\hat{\jmath} + 5\hat{k} = \dfrac{3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}}{\sqrt{50}}$ Directional derivative $= \nabla\phi \cdot \hat{n} = \dfrac{46}{\sqrt{50}}$	1 mark 2 *marks*
	ii)	Given the vector field $\vec{V} = (x - y^2 + 2xz)\,\vec{\imath} + (xz - xy + yz)\,\vec{\jmath} + (z^2 + x^2)\,\vec{k}$. Find curl **of** $\vec{V}$. Show that the vectors given by curl of $\vec{V}$ at point A (1, 2,-3) and B (2,3,12) are orthogonal.  	
	(C)	Attempt any one	04
	i)	$\vec{V} = \vec{\omega} \times \vec{r}$, prove that $\vec{\omega} = \frac{1}{2}$ curl $\vec{V}$, *where* $\vec{\omega}$ is a constant vector. Find $\vec{V} = \vec{\omega} \times \vec{r}$ — 2 marks Find Curl **V** & prove the required relation . — 2 marks	
	ii)	If $\vec{A} = 2\vec{\imath} - 3\vec{\jmath} - \vec{k}$ and $\vec{B} = \vec{\imath} + 4\vec{\jmath} - 2\vec{k}$ Find $\vec{A} \cdot \vec{B}$ and $\vec{A} \times \vec{B}$. Dot product = (-8) — 2 marks Cross Product = $(10\hat{\imath} + 3\hat{\jmath} + 11\hat{k})$ — 2 marks	

Q.3	(A)	Attempt any one	08
	i)	A source of constant emf is connected across a series combination of an inductor and a resistance. Derive an expression for the current in the circuit at time t, after the circuit is switched ON. Circuit Diagram — 2 marks Differential equation for the circuit $L(di/dt) + iR = E$ — 1 mark $(di/dt) + (R/L)I = E/R$ Solving the equation $i = i_m(1 - e^{(-R/L)t})$ — 5 mark	
	ii)	Describe the method to solve second order homogeneous linear ordinary differential equation with constant coefficients when the roots are real and unequal. Write the general form of second order homogeneous ordinary differential equation $y'' + p_0y' + q_0y = 0$ — 1 mark Write the auxiliary equation and solve — 3 marks Get the solution for the case when the roots are real and unequal $y = C_1e^{m1x} + C_2e^{m2x}$ — 4 marks	
	(B)	Attempt any one	08
	i)	A capacitor of capacitance C is initially charged to a value q_m. It is made to discharge through a resistance R. Show that the charge on the capacitor decays exponentially with time. Define time constant. Circuit Diagram — 2 marks Differential equation for the circuit $R(dq/dt) + (q/C) = 0$ — 1 mark $(dq/dt) + (q/RC) = 0$ $(dq/q) = -(dt/RC)$ Solving; $q = q_me^{(-t/\tau)}$; where $\tau = RC$ — 5 marks Thus charge decreases exponentially	
	ii)	Show that the following equation is exact and find its solution. $(4x^3+6xy+y^2)\,dx+(3x^2+2xy+2)\,dy=0$. Condition for the equation to be exact — 1mark $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x} = 6x + 2y$ — 3 mark Solving the equation Solution : $F(x,y) = x^4+3x^2y + xy^2 + 2y$ — 4 marks	

	(C)	Attempt any one	04
	i)	In a series LCR circuit, L=2mH and C=2000pF. What is the maximum value of the resistance required to make the circuit oscillatory? Condition for the circuit to be oscillatory $(R^2/4L^2) < 1/(LC)$ 1 mark R< 2kΩ 3 marks	
	ii)	Solve the equation $\frac{d^2y}{dx^2} - 10\frac{dy}{dx} + 25y = 0$ Auxiliary equation (D2-10D+25) =0 1 mark Roots real & equal – 5 Solution y= $(C_1x + C)e^{5x}$ 3 marks	
Q.4	(A)	Attempt any one	08
	i)	Discuss the composition of two parallel S.H.M.s of the same period. Show that the resultant motion is also a S.H.M. having the same period and obtain the expression for the resultant amplitude. Let the two SHMs be represented by $x_1 = A \sin(\omega t+\alpha)$ $x_2 = B\sin(\omega t + \beta)$ 1 mark Using superposition principle derive the expression for the resultant $x=R \sin(\omega t+\delta)$ 3 marks Derive expression for the resultant ampliture $R^2 = A^2 + B^2 + 2AB\cos\delta$ where $\delta = \alpha-\beta$ 4 marks	
	ii)	Obtain an expression for velocity of transverse waves along a stretched uniform string. Relevant diagram 2 marks Derivation of equation $v = \sqrt{\frac{T}{m}}$ 6 marks	
	(B)	Attempt any one	08
	i)	Discuss the composition of two perpendicular S.H.M.s of the same period and show that the path of the resultant motion, in general, is an inclined ellipse. Sol: Consider two SHMs represented by $x = A \sin(\omega t + \alpha)$ $y = B\sin(\omega t + \beta)$ 1 mark Solve and get the equation of the resultant path followed by the particle $\frac{x^2}{A^2} + \frac{y^2}{B^2} - \frac{2xy}{AB}\cos\delta = \sin^2\delta$	

(6)

		The above equation is a general equation of an ellipse inclined to coordinate axes 7 marks	
	ii)	What are standing waves? Explain standing waves on string. What are nodes and antinodes. Definition 2 marks Explanation 2 marks Nodes and antinodes explanation 4 marks	
	(C)	Attempt any one	04
	i)	Two parallel SHMs acting on a particle are given by $x_1 = 5 \sin(\pi t + \pi/3)$ and $x_2 = 5 \sin(\pi t + \varphi)$. What should be minimum value of φ so that the resultant amplitude has maximum value . Maximum resultant value when $\varphi = \pi/3$ 4 marks	
	ii)	A particle is subjected to two perpendicular S.H.M.s given by, $x = 4\sin 4\pi t$ $y = 4\cos 4\pi t$ Describe the resultant motion of the particle. R=4 Units 1 Mark T=0.5 sec. 1mark Resultant motion Circular - 2 Marks	
Q.5	Attempt any four		20
	i)	Explain Solenoidal field with two examples. Definition of Solenoidal field 1 marks Each example for 2 marks	
	ii)	Determine the value of p so that $\vec{A} = 2\hat{i} + p\hat{j} + \hat{k}$ and $\vec{B} = 2\hat{i} - 2\hat{j} - 2\hat{k}$ are perpendicular. A. B= 0 Substitutions ----------2 Marks answer p=1 ------------2 Marks	
	iii)	An inductance of 4H and a resistance of 1Ω are connected in series with a dc source of 6V emf. Calculate the current in the circuit 4second after it is switched on. τ= 4secs ---------- 1 Marks Formula & substitution: ----------2 Marks I=3.8 A ------------ 2 Marks	

	iv)	Consider a body starting from rest and falling under gravity. what will be its velocity after t seconds? Write differential equation ---------- 1 Mark Solution of diff.eqn. ------------------ 4 Marks	
	v)	What are Lissajous Figures? What factors do their shapes depend upon? Definition: 1 mark, Four factors: 4 marks	
	vi)	A particle is subject to two perpendicular S.H.M.s $x = A \cos\omega t$ $y = A \cos(\omega t - \frac{\pi}{4})$ Find the trajectory of the particle. Expression for the resultant ------4 Marks Trajectory of particle oblique ellipse---------- 1 Mark	
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