Name:	UPES
Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Programme Name: B.Tech Mechanical Engineering **Semester : I**
Course Name : Physics **Time : 03 hrs**
Course Code : PHYS 1005 **Max. Marks: 100**
Nos. of page(s) : 02

Instructions: 1. In section A, all questions are compulsory. In section B, questions 6, 7 and 8 are compulsory, while question 9 have choice. In section C, question 10 is compulsory while Q 11 have a choice.
2. All bold letters are vectors.
3. The value of constants are given in table.

Quantity	Values
Magnetic constant (vacuum permeability) (μ_0)	1.25×10^{-6} N·A^{-2}
Electric constant (vacuum permittivity) (ε_0)	8.85×10^{-12} F·M^{-1}
Elementary charge	1.60×10^{-19} C

SECTION A

S. No.		Marks	CO
Q 1	Let $\rho_v=(x+2y+3z)\frac{C}{m^3}$ in the cubical region 0≤ x, y, z ≥1mm and $\rho_v=0$ outside the cube. What is the total charge contained within the cube.	4	CO2
Q 2	The temperature variation inside the earth can be assumed to be spherically symmetric and approximately described by the following equation: $T(r) = T_0 - \alpha r^2$, where r is the distance measured from the center of the earth. Calculate the gradient of T?	4	CO1
Q 3	Write the Maxwell's Equations with their physical significance.	2+2 =4	CO4
Q 4	Define the Laplacian of a scalar field. Find the Laplacian of the scalar field. $U=\rho^2 z\cos\varphi$	1+3 =4	CO2
Q 5	Explain the polarization in polar and nonpolar dielectrics	2+2 =4	CO3

SECTION B

Q 6	(a) Let $V = x^2y^2z$ in a region ($\varepsilon = 2\varepsilon_o$) defined by $-1 < x, y, z < 1$. Find the charge density ρ_v in the region.	5+5 =10	CO3

	(b) If the charge travels at $10^4 y$ $\mathbf{a}_y$ m/s, determine the current crossing surface $0 < x, z < 0.5, y = 1$.		
Q.7	State and prove the Poynting's theorem. Discuss the physical significance of each term in the resulting equation.	**2+5 +3= 10**	**CO5**
Q 8	Define the electric fields due to continuous charge distributions. Derive the expression for the electric field due to surface charge.	**3+7 =10**	**CO3**
Q 9	What are boundary conditions? Prove that, in case of dielectric- dielectric medium, the tangential components of electric field is continuous and normal component of **E** is discontinuous at the boundary **OR** Region 1 ($z < 0$) contains a dielectric for which $\varepsilon_r = 2.5$, while region 2 ($z > 0$) is characterized by $\varepsilon_r = 4$. Let $\mathbf{E_1} = -30\mathbf{a_x} + 50\mathbf{a_y} + 70\mathbf{a_z}$ V/m and find: (a) $\mathbf{D_2}$ (b) $\mathbf{P}_2$ (c) the angle between $\mathbf{E_1}$ and the normal to the surface.	**2+4 +4= 10**	**CO2**
	SECTION C		
Q. 10	[i] State the Faraday's law. Explain the variation of flux with time in cases (a) by having a stationary loop in a time-varying B field (b) by having a time-varying loop area in a static B field. [ii] A parallel-plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage 50 sin $10^3 t$ volt applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$.	**2+4 +4= 10**	**CO4** **CO5**
Q. 11	[i] Discuss the reflection and transmission coefficient. Explain the reflection of EM wave by a perfect dielectric. Polystyrene has a relative permittivity of 2.56. If a wave is incident at an angle of $\theta_i = 35^0$ from air to polystyrene. Calculate the angle of transmission θ_t. [ii] Derive wave equations for electric and magnetic fields and find the velocity of an electromagnetic wave in a lossless medium. **OR** [i] Find the reflection coefficient and transmission coefficient of an electric field wave travelling in air and incident normally on a boundary between air and a dielectric having permiability = μ_0 and permittivity $\varepsilon_r = 4.74$ [ii] Define the momentum carried by electromagnetic wave. Derive its expression also.	**10+ 10 = 20**	**CO6**

CONFEDENTIAL

Name of Examination (Please tick, symbol is given)	:	**MID**		**END**	☐	**SUPPLE**	**NA**
Name of the School (Please tick, symbol is given)	:	**SOE**	☐	**SOCS**		**SOP**	
Programme	:	**B.Tech Mechanical Engineering**					
Semester	:	**First Semester**					
Name of the Course	:	**Physics**					
Course Code	:	**PHYS 1005**					
Name of Question Paper Setter	:	**Dr Rajeev Kumar Gupta**					
Employee Code	:	**40000040**					
Mobile & Extension	:	**9897716629, 1414**					
Note: Please mention additional Stationery to be provided, during examination such as Table/Graph Sheet etc. else mention "NOT APPLICABLE":							

FOR OFFICE USE

Date of Examination	:	
Time of Examination	:	
No. of Copies (for Print)	:	

Note: - Pl. start your question paper from next page

Name:	UPES
Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Programme Name: B.Tech Mechanical Engineering **Semester : I**
Course Name : Physics **Time : 03 hrs**
Course Code : PHYS 1005 **Max. Marks: 100**
Nos. of page(s) : 02

Instructions: 1. In section A, all questions are compulsory. In section B, questions 6, 7 and 8 are compulsory, while question 9 have choice. In section C, 10 is compulsory and Q11 have choice.
2. All bold letters are vectors.
3. The value of constants are given in table.

Quantity	Values
Magnetic Constant (Vacuum Permeability) (μ_0)	1.25×10^{-6} N·A^{-2}
Electric Constant (Vacuum Permittivity) (ε_0)	8.85×10^{-12} F·m^{-1}
Elementary Charge	1.60×10^{-19} C

SECTION A

S. No.		Marks	CO
Q 1	Find the total charge in the volume defined by 0≤ x ≥1m, 0≤ y ≥1m, 0≤ z ≥1m, if $\rho_v = 120\,x^2 y \frac{\mu C}{m^3}$.	4	CO2
Q 2	Using cylindrical co-ordinates show that: $[\nabla\times(\nabla V)]_\rho = 0 = [\nabla\times(\nabla V)]_\phi$	4	CO1
Q 3	Define the Laplacian of a scalar field. Find the Laplacian of the scalar field $P = 10\,r\sin^2\theta\cos\phi$	4	CO1
Q 4	The potential field V = $2x^2yz - y^3z$ exists in a dielectric medium having ε= $2\varepsilon_o$. Does V satisfy Laplace's equation?	4	CO2
Q 5	Write Maxwell's equations for time varying field.	4	CO4

SECTION B

Q.6	Derive the Continuity equation div **J** + $\frac{\partial \rho}{\partial t}$ = 0 and write its physical significance. Prove that the volume charge density decays exponentially with a time constant.	10	CO5

Q.7	Given the magnetic vector potential $\mathbf{A} = -\rho^2/4\ \mathbf{a_z}$ Wb/m, calculate the total magnetic flux crossing the surface $\phi = \pi/2$, $1 \le \rho \le 2$ m, $0 \le z \le 5$m.	**10**	**CO3**
Q 8	[i] Calculate the value of Poynting's vector at the surface of the sun if the power radiated by the sun is $3.8\text{x}10^{26}$ watt while its radius is $7\text{x}10^{8}$ m. [ii] If the average distance between the sun and the earth is $1.5\text{x}10^{11}$ m, show that the average solar energy incident on the earth is 2 cal/cm^2	**10**	**CO5**
Q 9	Define the magnetic materials and explain its two properties. What is the Faraday's law? Explain it by having a time-varying loop area in a time-varying B field. **OR** A long solenoid of diameter 0.1 m has $2\text{x}10^{4}$ turns per meter. At the center of the solenoid, a 100 turn coil of radius 0.01 m is placed with the axis coinciding with the solenoid axis. The current in the solenoid is decreased at a constant rate from 2A to -2 A in 0.5 seconds. Find the emf induced in the coil. Also, find the total charge flowing through the coil during this time when the resistance of the coil is $10\pi^2$ ohm.	**10**	**CO4**
	SECTION-C		
Q. 10	[i] Explain the concept of displacement current. Show that for a conductor subject to electric field $E=E_0 \cos\omega t$, displacement current density is negligible at a frequencies less than 10^{15} c/s [ii] Find the vector potential of an infinite solenoid with n turns per unit length, radius R, and current I.	**10+10 = 20**	**CO2** **CO3**
Q. 11	[i] Assume a plane wave with E=1V/m and a frequency of 300 MHz moving in a free space, impinges on a thick copper located perpendicularly to the direction of propagation. Find the value of E and H. [ii] Define the electromagnetic wave. Prove that the wave equation for E and H are $\nabla^2 E = \mu\varepsilon \frac{\partial^2 E}{\partial t^2}$ and $\nabla^2 H = \mu\varepsilon \frac{\partial^2 H}{\partial t^2}$. **OR** Define the reflection and the transmission of the EM wave. Prove that for the EM wave, parallel polarization $\frac{E_r}{E_i} = \frac{\tan(\theta_i - \theta_t)}{\tan(\theta_i + \theta_t)}$ and for perpendicular polarization $\frac{E_r}{E_i} = \frac{\sin(\theta_t - \theta_i)}{\sin(\theta_t + \theta_i)}$.	**20**	**CO6**