City College

Internal Examination-2020

Physics (Hons) (1+1+1)

Part-I: Paper I

Time: 2 hours 30 minutes **Full Marks: 50**

Answer any **ten** questions. Each question carries **5 marks**. 10×5=50

1. (a) If $\vec{A}$ is a constant vector, find grad($\vec{A} \cdot \vec{r}$).

(b) Deduce$\vec{\nabla} \times (\varphi \vec{A}) = (\vec{\nabla}\varphi) \times \vec{A} + \varphi(\vec{\nabla} \times \vec{A})$. 2+3

2. Given the vector $\vec{A} = (x^2 - y)\hat{\imath} + 2x\hat{\jmath} + 2\hat{k}$. Evaluate $\oint \vec{A}.d\vec{r}$ around the boundary of a circle $x^2 + y^2 = 1$.

3. Find the eigenvalues and the normalized eigenvector of the matrix M=$\begin{pmatrix} 2 & 2 \\ 2 & -1 \end{pmatrix}$.

4. Consider the matrices σ_1=$\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$, σ_2=$\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$, σ_3=$\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$. Which of these is/are Hermitian? Which is/are unitary? 2+3

5. (a) Check whether the series $\sin x$ converges for all x.

(b) Expand $\cos x$ about x=$\frac{3\pi}{2}$. 3+2

6. (a) State the order and degree of the following differential equation: $\frac{d^3y}{dx^3}+\left(\frac{dy}{dx}\right)^2 + xy = 0$

(b) Consider the differential quantity $(x^2 - y)dx + xdy$. Is it an exact differential? 2+3

7. (a) Consider the function $f(x) = \sin x \ for\ 0 < x < \pi,$

$= -\sin x \ for - \pi < x < 0.$

$f(x + 2\pi) = f(x)$. Find the Fourier series expansion of f(x).

8. A mass of 1 kg is acted on by a restoring force with force constant 4N/m and a resisting force with damping co-efficient 2N-s/m. Write down the equation of motion in 1-D. Find: (i) whether the motion is periodic or oscillatory (ii) the value of resisting force which will make the motion critically damped. 1+2+2

9. Define phase velocity and group velocity. Obtain the relation between group velocity and phase velocity. 2+3

10. (a) The band gap of a specimen of GaAs is 1.95eV. Determine the wavelength of electromagnetic wave radiated upon recombination of holes and electrons.

(b) Why we cannot measure the barrier potential existing across a p-n junction by connecting a voltmeter across the junction?

(c) State Thevnin's theorem. 2+2+1

11. (a) Draw a sketch of the drain characteristics of a MOSFET and identify different regions.

(b) Why FET's can be used at higher frequencies than BJT's? 3+2

12. (a) Draw the circuit diagram of XNOR gate using basic gates and write down its truth table.

(b) Verify the Boolean identity: $A + B + A\bar{B}C + BC = A + B$. 3+2

---End of Question Paper---

E-mail the scanned copy of answer script to **part1hcityphysics@gmail.com** within **15 minutes** after the end of the examination.