2019

B.Sc. (Honours)

5th Semester Examination

PHYSICS

Paper - DSE-1T

Full Marks : 40 Time : 2 Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

(ADVANCED MATHEMATICAL PHYSICS-I)

1. Answer any *five* questions from the following : 2×5=10

   (a) State the change of scale property of Laplace transform.

   (b) Define orthonormal vector set.

   (c) What do you mean by Riemannian metric tensor ?

(d) Find the Laplace transform of $\cos^2 2t$.

(e) State the Quotient Law for tensor analysis.

(f) Define the norm of a vector.

(g) Define the basis for a vector space.

(h) Show that $\begin{pmatrix} i & 0 \\ 0 & 1 \end{pmatrix}$ is a unitary matrix.

2. Answer any *four* questions from the following : $5\times4=20$

(a) Find the Laplace transform of the square wave (period a) defined by

$$F(t)=\begin{cases} 1\ , & 0<t<\dfrac{a}{2} \\ 0\ , & \dfrac{a}{2}<t<a \end{cases}$$ 5

(b) Obtain the solution of the second order ordinary differential equation for damped oscillator given as follows : 5

$$mX''(t) + bX'(t) + kX(t) = 0$$

by the method of Laplace transform with the initial conditions $X(0) = X_0$ and $X'(0) = 0$ and symbols having usual meanings. 5

(c) Show that the symmetric (or anti-symmetric property of a tensor is conserved under transformation of coordinates. 5

(d) Show that the covariant derivative of a fundamental tensor is zero. 5

(e) Show that any inner product of the tensors A_r^p and B_t^{qs} is a tensor of rank three. 5

(f) Using partial fraction expansions, show that

$$L^{-1}\left\{\frac{1}{(s+a)(s+b)}\right\} = \frac{e^{-at} - e^{-bt}}{b-a};\ a \neq b. \quad 5$$

[Turn Over]

3. Answer any *one* question from the following : 10×1=10

(a) (i) State and prove the convolution theorem in Laplace transform.

(ii) Using the convolution integral calculate

$$L^{-1}\left\{\frac{1}{\left(s^2+a^2\right)\left(s^2+b^2\right)}\right\};\ a^2 \neq b^2$$

2+4+4

(b) (i) Describe the Gram-Schmidt orthogonalization process.

(ii) Form a set of three orthonormal vectors by the Gram-Schmidt process using those input vector in the order given :

$$C_1 = \begin{pmatrix}1\\1\\1\end{pmatrix},\ C_2\begin{pmatrix}1\\1\\2\end{pmatrix},\ C_3\begin{pmatrix}1\\0\\2\end{pmatrix}$$

4+6

(APPLIED DYNAMICS)

1. Answer any *five* questions from the following : 2×5=10

(a) Give the definition of a continuous first order dynamical system.

(b) What is Population models ?

(c) Give the examples of dynamical systems in chemistry.

(d) What is logistic map ?

(e) Give some examples of chaotic systems.

(f) What is fractal geometry ?

(g) What is Cobweb iteration ?

(h) Write down the importance of fluids in the pure sciences and in technology.

[Turn Over]

2. Answer any *four* questions from the following : 5×4=20

(a) What is streamline and turbulent motion ? What is laminar flow ? What is fluid-shear stress ?

(b) Explain the continuum hypothesis-concept of fluid elements or fluid parcel.

(c) Compare deterministic fractal vs. self-similar fractal structure.

(d) Write down the equations and draw the curves for exponential growth and decay, logistic growth.

(e) What are phase space, flows and trajectories ? Give some examples.

(f) Write short note on fractal geometry ?

3. Answer any *one* question from the following : 10×1=10

(a) Solve the differential equation for damped harmonic oscillator. Hence explain small damping. Explain the free failing of particle and particle falling under uniform gravity.

(b) Explain projection of the trajectory on momentum space. How you detect chaos from return map ? Write short note on Fluid properties-viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state.

(ATMOSPHERIC PHYSICS)

1. Answer any *five* questions from the following : 2×5=10

(a) Give the examples of instrument for meteorological observations.

(b) What is ionosphere ?

(c) Give the examples of Fundamental forces in nature.

(d) Give is Greenhouse effect ?

(e) Give applications of radar systems.

(f) Compare Lamb wave, Rossby waves.

(g) Wha is Coriolis force ?

(h) What are Cyclones and anticyclones ?

2. Answer any *four* questions from the following : 5×4=20

(a) Derive the equation for propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium.

(b) Explain the continuum hypothesis-concept of fluid element or fluid parcel.

(c) Write short note on Spectral distribution of the solar radiation.

(d) Write down the Classification and properties of aerosols, production and removal mechanisms.

(e) What are Atmospheric oscillations, quasi biennial oscillation, annual and semi-annual oscillations ?

(f) Write short note on Radar and Lidar.

3. Answer any *one* question from the following : 10×1=10

(a) What are Rayleigh scattering and Mie scattering ? Write down Bouguert-Lambert law. Derive Rayleigh scattering formula.

[Turn Over]

(b) Write down the Radar equation. What is return signal ? How Signal processing and detection are done in radar system ? Write down the classifications of various type of amospheric radars.

(CLASSICAL DYNAMICS)

Full Marks : 60 Time : 3 Hours

1. Answer any *ten* questions from the following : 2×10=20

(i) What is Reynolds number ?

(ii) Define stable and unstable equilibrium in classical mechanics.

(iii) What is the advantages of Lagrangian formulation over the Newtonian formulation ?

(iv) Explain the terms flow line and stream line.

(v) Write down Lorentz transformations between two reference frames S and S' when S'-frame is moving with uniform speed v with respect to S-farme along their common axes X, X'.

(vi) What do you meant by 'four-vector' ?

(vii) What do you mean by critical velocity in connection mean of streamline flow of liquid.

[Turn Over]

(viii) Explain the term-length contruction.

(ix) What is cycle co-ordinate ? Give an example.

(x) What is ideal fluid ?

(xi) What do you meant by "small amplitude oscillation" ?

(xii) What are the advantages of Hamiltonian mechanics over Lagrangian mechanics ?

(xiii) Write down the expression of force acted on a particle when it moves along a electric field and magnetic field both.

(xiv) Name the transformation under which Maxwell's equations are invariant.

(xv) Two particles are moving along straight line toward eachother with a uniform velocity 0.8 C. Calculate the relative velocity of approach between them.

2. Answer any *four* questions from the following. 5×4=20

(a) The Lagrangian for an anharmonic oscillator is given by :

$$L(x,\dot{x}) = \frac{1}{2}\dot{x}^2 - \frac{1}{2}w^2x^2 - \alpha x^3 + \beta x\,\dot{x}^2$$

Find the corresponding Hamiltonian. 5

(b) Show that if T is the K. E. of a particle and p its momentum, its rest mass is given by

$$m_o = \frac{p^2c^2 - T}{2Tc^2}$$ 5

(c) Derive Einestein's velocity addition theorem. 5

(d) Calculate the velocity of efflux of kerosene oil from a tank in which the pressure is 8 cm of Hg above atmospheric pressure. The density of kerosene in 0.8 g/cm^3. Atmospheric pressure = 76 cm Hg. Density of mercury = 13.6 gm/c.c. 5

[Turn Over]

(e) The Lagrangian of a charge particle in an electromagnetic field is given by

$$L = T - q\left(\varphi - \frac{1}{c}\bar{v}.\bar{A}\right)$$

Find the Hamiltonian of the system and interpret it. 5

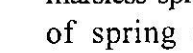
(f) Water flows along a horizontal tube of which the cross-section is not constant. Calculate the change in pressure when the velocity of flow changes from 10cm/s to 20 cm/s. Indicate about the sign of the change of pressure. 4+1

3. Answer any *two* questions from the following : 10×2=20

(i) (a) State the Bernoullis theorem in fluid mechanics.

Deduce it from Euler's equation of fluid dynamics for irrotational flow of an incompressible fluid. 2+4

(b) A rod 1 m is moving along its length with a velocity 0.6c. Calculate its length as it appears to (1) and observer on the earth (2) moving with the rod itself. 4

(ii) (a) Three particles of equal mass m move without friction in one dimension. Two of the particles are each connected to the third by marsless spring () of spring constant K. Find the eigen frequencies using small oscillation. 6

(b) The potential energy between a pair of atom is given by $U = -\frac{\alpha}{r^6} + \frac{\beta}{r^{12}}$. Calculate the equilibrium interatomic separation for which potential energy is minimum. 4

(iii) (a) State the basic postulates of Einstein's special theory of relativity. Show by means of Lorentz transformation equations that

$$x'^2 - c^2t'^2 = x^2 - c^2t^2$$

symbols are meaning the usual means. 2+4

(b) Find the velocity at which the mass of a particle becomes double its rest mass.

What is 'time-line' in four vectors ? 3+1

[Turn Over]

(iv) (a) The point of suspension of a simple pendulum moves harmonically along the vertical line. Find the Lagrangian. 4

(b) A bead of mass m slides without friction on a frictionless wire in the sharp of a cycloid with equation

$$x = a(\theta - \sin\theta),\ y = a(1 + \cos\theta)$$

where $0 \le \theta \le 2\pi$. Find the Lagrangian and Lagrangian equation of motion. 4

(c) On the basis of Lorentz transformation equation discuss the "time dilatron". 2
