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UG/5th Sem/Phys(H)/T/19

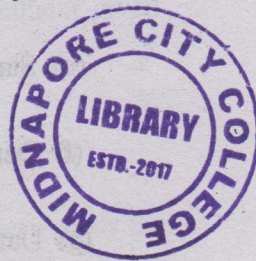
2019

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.*

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(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 ?

[Turn Over]

(2)

- (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 :

5×4=20

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

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

(3)

- (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_i^{qs} is a tensor of rank three. 5

- (f) Using partial fraction expansions, show that

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

[Turn Over]

(4)

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

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

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

(5)

(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.

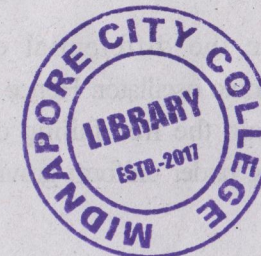
(d) What is logistic map ?

(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]

(6)

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 falling of particle and particle falling under uniform gravity.

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(7)

- (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.

[Turn Over]

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(8)

(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 ?

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(9)

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.

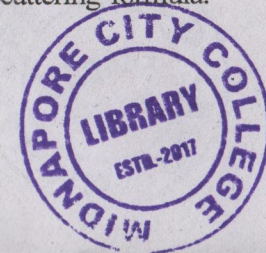
3. Answer any *one* question from the following :

10×1=10

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

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(10)

- (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.

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(11)

(CLASSICAL DYNAMICS)

Full Marks : 60

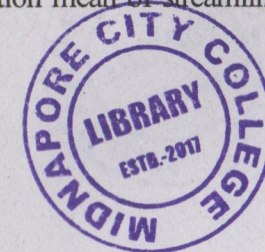
Time : 3 Hours

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.

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(12)

- (viii) Explain the term-length contraction.
- (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.

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(13)

2. Answer any *four* questions from the following.

5×4=20

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

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

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

$$m_0 = \frac{p^2 c^2 - T}{2Tc^2} \quad 5$$

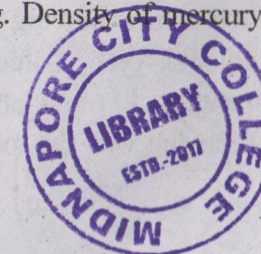
(c) Derive Einestein's velocity addition theorem. 5

- (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 is 0.8 g/cm^3 . Atmospheric pressure = 76 cm Hg. Density of mercury = 13.6 gm/c.c.

5

[Turn Over]

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(14)

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

$$L = T - q \left(\phi - \frac{1}{c} \vec{v} \cdot \vec{A} \right)$$

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 Bernoulli's 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) an observer on the earth (2) moving with the rod itself. 4

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(15)

- (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 massless spring ($m \text{---} \text{spring} \text{---} m \text{---} \text{spring} \text{---} m$) 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

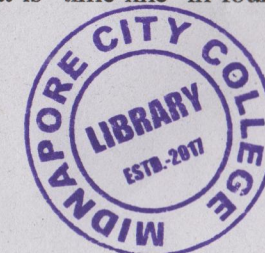
$$x'^2 - c^2 t'^2 = x^2 - c^2 t^2$$

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]

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(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 shape of a cycloid with equation

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

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

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

