

Name of Course : B.Sc. Prog.s.-CBCS\_NC\_Core

Semester : I-Semester

Name of the paper : Mechanics

Unique Paper Code : 42221101

Duration: 3 Hours

Maximum Marks: 75

**Note: Attempt any four questions.**

1. (a) Explain gradient, divergence and curl. (6)  
(b) If  $\vec{A} = 2\hat{i} + \hat{j} - 3\hat{k}$ ,  $\vec{B} = \hat{i} - 2\hat{j} + \hat{k}$  and  $\vec{C} = -\hat{i} + \hat{j} - 4\hat{k}$  deduce the values of  
(i)  $\vec{A} \cdot (\vec{B} \times \vec{C})$  (ii)  $\vec{C} \cdot (\vec{A} \times \vec{B})$  (iii)  $\vec{A} \times (\vec{B} \times \vec{C})$  (iv)  $(\vec{A} \times \vec{B}) \times \vec{C}$  (8.75)  
(c) Show that the force  $\vec{F} = (y^2z^3 - 6xz^2)\hat{i} + 2xyz^3\hat{j} + (3xy^2z^2 - 6x^2z)\hat{k}$  is conservative. (4)
2. Using the law of conservation of momentum obtain the equation of rocket. A rocket starts from rest with an initial mass  $M_0$  and reaches a final velocity  $v_f$  when its mass is  $M_f$ , show that  
$$\frac{M_f}{M_0} = e^{-v_f/v_{rel}}$$
 where  $v_{rel}$  is the exhaust velocity. (18.75)
3. (a) State and prove work-energy theorem. (8)  
(b) Explain the concept of centre of mass. Show that in the absence of external forces the velocity of the centre of mass remains constant. (10.75)
4. (a) State Newton's law of gravitation. Prove that the angular momentum is conserved under the action of a central force. (8)  
(b) What is a satellite? Write any three applications of satellite. Derive the expression for the time period of a satellite. (10.75)
5. (a) Derive the equation of motion of a simple harmonic motion and obtain the expression for its velocity, time period and frequency. (13.75)

- (b) Prove that the function  $A \cos \omega t + B \sin \omega t$  can be written as  $C \cos (\omega t - \phi)$ . Define the different parameters in the above function and write its amplitude, period and frequency. (5)
- (c) (a) What do you understand by time dilation, deduce an expression for time dilation on the basis of Lorentz transformations. (6)
- (b) Derive the formula for the variation of the mass of particle with its velocity. (8.75)
- (c) A rod 1.0 meter long is moving along its length with a velocity of  $0.6c$ . Calculate the length as it appears to a stationary observer? (4)