Roll No. ....

3004

B. Tech. 1st Semester (Civil Engg.)

Examination – December, 2018

MECHANICS

Paper : BSC-PHY-104-G

Time : Three Hours] *[Maximum Marks : 75*

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt *five* questions in all, selecting at least *one* question from each Unit. Question No. 1 is *compulsory*. All questions carry equal marks.

1. (a) Explain conservative and non-conservative forces. 2.5

(b) What do you mean by inertial and non-inertial frame of references ? 2.5

(c) If potential energy $(V) = x^2y + xy^2 + xyz$ then write the equation of force at point P (1, 2, –2,) by using equation $\vec{F} = -\vec{\nabla} V$ 2.5

(d) Define equipotential surface and show that conservative force is perpendicular to equipotential surface. 2.5

(e) Define inertia tensor and give its physical significance ? 2.5

(f) Convert Cartesian co-ordinates into polar coordinates (r, θ) for two dimensional system (x-y plane). 2.5

UNIT – I

2. (a) Show how scalars and vectors can be transformed under rotation transformations. 8

(b) Write short note on constraints and its types (with example). 7

3. (a) State and prove law of conservation of linear momentum and derive equation of velocity and acceleration in polar coordinates. 8

(b) A block of mass 5kg is placed on top of 10 kg block. They are then attached through a massless and frictionless pulley to a mass M as shown in figure 1. The coefficient of friction between all surfaces for both static and dynamic friction is 0.5. What is the acceleration of M for (a) M = 20kg and (b) M = 40kg. ($g = 9.8 m/s^2$) 7

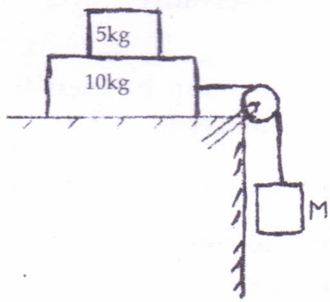

Figure 1

UNIT – II

4. (a) What is Coriolis force ? Show that total Coriolis force acting on a body of mass 'm' in a rotating frame is $-2m\,(\vec{\omega} \times \vec{v})$, where $\vec{\omega}$ is angular velocity of rotating frame and $\vec{v}$ is velocity of body. 8

(b) Derive five term acceleration formula for rotating coordinate system and explain each term. 7

5. Define damped harmonic oscillations and write its differential equation. Solve differential equation and discuss all special cases e.g. over-damped, critically damped and lightly-damped oscillations. 15

UNIT – III

6. (a) Define angular displacement, velocity and acceleration. Derive the expression of rotational kinetic energy of a rigid body. 8

(b) Explain in brief about angular momentum of a rigid body about center of mass and any arbitrary point in planar motion and also prove that angular momentum of rigid body always remain conserved in the absence of external force. 7

7. (a) What do you mean by inertia tensor, principle axes and principle moment of inertia ? How will you determine the principle moment of inertia of a rigid body and direction of principle axis ? 8

(b) Deduce Euler's equations of motion by Newtonian method. 7

UNIT – IV

8. (a) Write short notes on frictional forces and their types. 8

(b) A block of weight 1000N is pulled by aforce F as shown in figure 2 (a). If this force has a time variation as shown in figure 2 (b), draw a simple sketch showing variation of frictional force with time and explain its variation. Take $\mu_S = 0.3$ and $\mu_d = 0.2$ for this problem. 7

Figure 2a

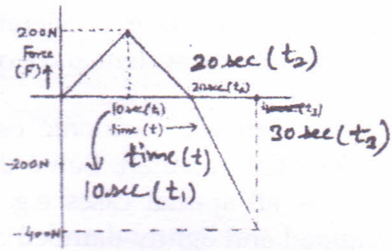

Figure 2b

9. (a) What do you mean by deformation and explain different steps used to analyse and solve deformed body by taking any one example. 8

(b) A flexible belt is wrapped over portion of drum which can freely rotate about point C as shown in figure 3. If μ_S is co-efficient of static friction between drum and belt then show that $\frac{T_1}{T_2} = e\mu_S\beta$. Given that $T_1 > T_2$. 7

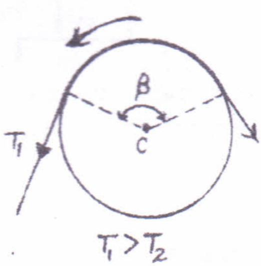

Figure 3