Enrollment No: _____ Exam Seat No:_____

C.U.SHAH UNIVERSITY
Winter Examination-2015

Subject Name :Introduction to Mathematical Physics and Classical Mechanics

Subject Code :4SC05MCC1 **Branch :B.Sc. (Physics)**

Semester :5 **Date :02/12/2015** **Time :02:30 To 05:30** **Marks :70**

Instructions:

(1) Use of Programmable calculator & any other electronic instrument is prohibited.
(2) Instructions written on main answer book are strictly to be obeyed.
(3) Draw neat diagrams and figures (if necessary) at right places.
(4) Assume suitable data if needed.

Q-1 **Attempt the following questions:** **(14)**

a) Write expression of divergence of a vector point function. 01
b) Write expression of curl of a vector point function. 01
c) Write expression of gradient of a scalar field. 01
d) Define curvilinear coordinates. 01
e) Write expression of condition for orthogonality. 01
f) What is Fourier series? 01
g) Write expression of Fourier series. 01
h) What is constraint? 01
i) Define Scleronomous constraint. 01
j) Define Rheonomous constraint. 01
k) Define generalized coordinates. 01
l) What is cyclic or ignorable coordinates? 01
m) Define configuration space. 01
n) Define phase space. 01

Attempt any four questions from Q-2 to Q-8

Q-2 **Attempt all questions** **(14)**

a) Discuss Eigen values and Eigen vectors. 04
b) If $x=uv\cos\omega$, $y=uv\sin\omega$, $z=(u^2-v^2)/2$, then find h_1, h_2, h_3 and show that $ds^2=(u^2+v^2)(du^2+dv^2)+uvd\omega^2$. 05
c) Determine Eigen values and Eigen vectors of $A=\begin{bmatrix}5 & 4\\ 1 & 2\end{bmatrix}$. 05

Q-3 **Attempt all questions** **(14)**

a) Obtain Fourier's series for the expansion of $f(x)=x\sin x$ in the interval of $-\pi<x<\pi$. Hence deduce that $\frac{\pi}{4}=\frac{1}{2}+\frac{1}{1.3}-\frac{1}{3.5}+\frac{1}{5.7}-\cdots$. 07

b) Find a series of sines and cosines of multiples of x. which will represent $x+x^2$ in the interval $-\pi<x<\pi$. Deduce that $\frac{\pi^2}{12}=\sum_{n=1}^{\infty}\frac{(-1)^{n+1}}{n^2}=1-\frac{1}{2^2}+\frac{1}{3^2}-\cdots$. 07

Q-4 **Attempt all questions** **(14)**

a) Derive the expression of divergence in terms of orthogonal curvilinear coordinates. 07

b) Derive the expression of curl in terms of orthogonal curvilinear coordinates. 07

Q-5 **Attempt all questions** **(14)**

a) Derive Lagrange's equations of motion for conservative system. 07

b) Explain in detail D'Alembert's principle. 07

Q-6 **Attempt all questions** **(14)**

a) Using Hamilton's formulation, discuss a simple pendulum with moving support. 07

b) Discuss Lagrange's undetermined multipliers. 07

Q-7 **Attempt all questions** **(14)**

a) Write importance of Lagrangian formulation. 05

b) Discuss Rayleigh's Dissipation function. 05

c) Derive the expression of the kinetic energy of the double pendulum. 04

Q-8 **Attempt all questions** **(14)**

a) Diagonalize the following matrix.A = $\begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$ 05

b) Find $\nabla\phi$ and $|\nabla\phi|$ for the function $2xz^4-x^2y$ at the point (2, -2, -1). 05

c) If $\mathbf{V}=x^2z\mathbf{i}-2y^3z^2\mathbf{j}+xy^2z\mathbf{k}$ find div$\mathbf{V}$ ($\nabla.\mathbf{V}$) at the point (1, -1, 1). 04