Sanjay Ghodawat University, Kolhapur 2018-19

Established as State Private University under Govt. of Maharashtra. Act No XL, 2017 EXM/P/09/00

Year and Program: 2018-19 F.Y. M. Sc.	**School of Science**	**Department of Mathematics**
Course Code – MTS 506	**Course Title – Classical Mechanics**	**Semester – II**
Day and Date – Friday 24-05-2019	**Examination: (ESE) End Semester Examination**	**Time:** 2.30 to 3.00 pm **Max Marks: 100**
PRN No.:	**Seat Number:** A	**Answer Book No.:**
Student's Signature:		**Invigilator's Signature:**

Instructions:

1) All questions are compulsory.
2) **Attempt Q.1 within first 30 minutes.**
3) Each MCQ type question is followed by four plausible alternatives, Tick (√) the correct one.
4) Answer to question 1 should be written in the question paper and submit to the Jr. Supervisor.
5) If you tick more than one option it will not be evaluated.
6) Figures to the right indicate full marks.
7) Use **Blue ball pen** only.

Q.1	**Attempt the following questions.**	Marks	Bloom's Level	COs
i)	In a simple conservative dynamical system, sum of kinetic energy and potential energy is (a) constant (b) non-constant (c) zero (d) varying	2	L_2	CO1
ii)	If the Lagrangian $L(x,\dot{x})$ corresponding to Atwood's machine is given as: $L(x,\dot{x})=\frac{1}{2}(m_1+m_2)\dot{x}^2+m_1gx+m_2g(l-x)$, where m_1, m_2, l and g are constants, then the equation of motion is (a) $\dot{x}=\frac{m_1-m_2}{m_1+m_2}g$ (b) $\dot{x}=\frac{m_1+m_2}{m_1-m_2}g$ (c) $\ddot{x}=\frac{m_1+m_2}{m_1-m_2}g$ (d) $\ddot{x}=\frac{m_1-m_2}{m_1+m_2}g$	2	L_3	CO2
iii)	Hamiltonian H is defined as the------------ of the system (a) total energy (b) difference in energy (c) product of energy (d) inverse of Lagrangian	2	L_2	CO3

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iv)	The Lagrangian of a particle moving in a plane under the influence of a central field of force is given by $L = \frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) - V(r)$ The generalized momenta corresponding to r and θ are given by (a) $m\dot{r}$ & $mr^2\dot{\theta}$ (b) $m\dot{r}$ & $mr\dot{\theta}$ (c) $m\dot{r}^2$ & $mr\dot{\theta}$ (d) None of these	2	L_3	CO4
v)	A particle is moving in an inverse square force field. If the total energy of the particle is positive, then trajectory of the particle is (a) Hyperbolic (b) Circular (c) Parabolic (d) Eliptical	2	L_3	CO4
vi)	Kepler's second law regarding consistency of arial velocity of the planet is the consequence of the law of conservation of (a) Energy (b) Angular Momentum (c) Linear Momentum (d) None of these	2	L_2	CO4
vii)	If the transformations are $Q = \frac{1}{p}$, $P = qp^2$, then the transformation is (a) canonical but not invertible (b) invertible but not canonical (c) point transformation. (d) canonical and invertible	2	L_3	CO5
viii)	Under the canonical transformation from the set of variables (p_k, q_k) to new set of variables (P_k, Q_k), the transformed Hamiltonian is identically zero, then the new variables are (a) constant in time. (b) not constant in time. (c) not cyclic. (d) None of the above.	2	L_2	CO5
ix)	For conservative system, Hamiton principle function S and Hamilton characteristic function W satisfy (a) $S = W$ (b) $S = W - Et$ (c) $S = W + Et$ (d) $W = S + Et$	2	L_2	CO5
x)	If $[X, Y]$ is the Poisson Bracket, then which of the following is not true (a) $[X, Y+Z] = [X, Y] + [X, Z]$ (b) $[X, Y] = -[Y, X]$ (c) $[X, YZ] = [X, Y]Z + Y[X, Z]$ (d) $[X, X] = 1$	2	L_2	CO5

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Year and Program:2018-19 M.Sc. I **School of Science** **Department of Mathematics**

Course Code: MTS 506 **Course Title: Classical Mechanics** **Semester – II**

Day and Date Friday 24-05-2019 **End Semester Examination (ESE)** **Time:** 3 to 5.30 pm **Max Marks: 100**

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Instructions:
1) All questions are compulsory.
2) Use of non-programmable calculator is allowed.
3) Figures to the right indicate full marks.

			Marks	Bloom's Level	CO
Q.2		**Solve any two**			
	a)	If the forces acting on a particle are conservative then show that the total energy is conserved.	06	L_2	CO1
	b)	Show that the total angular momentum of a system of particles can be expressed as the sum of the angular momentum of the motion of the centre of mass about origin plus the total angular momentum of the system about centre of mass.	06	L_2	CO1
	c)	Explain the motion of particle falling under the action of gravity near the surface of earth.	06	L_3	CO1
Q.3		**Solve any two.**			
	a)	Write a note on Brachistochrone problem.	07	L_3	CO2
	b)	Find the Euler-Lagrange differential equation satisfied by four times differential function $y(x)$ which extremizes the functional $I(y(x)) = \int_{x_1}^{x_2} f(x, y, y', y'')dx$, under the conditions that both y and y' are prescribed at the end points.	07	L_2	CO2
	c)	For conservative system, derive Lagrange's equation of motion from D' Alembert's principle.	07	L_3	CO2
Q.4		**Solve any two.**			
	a)	Show that the Hamilton's principle $\delta\int_{t_0}^{t_1} L dt = 0$ also holds for the non-conservative system.	07	L_2	CO3
	b)	Obtain Hamilton's equation of motion from the Hamilton's principle.	07	L_3	CO3

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			Marks	Level	CO
	c)	The Lagrangian for a particle moving on a surface of a sphere of radius r is given by $L = \frac{1}{2}mr^2\left(\dot{\theta}^2 + \sin^2\theta\ \dot{\phi}^2\right) - mgr\cos\theta$. Find Hamiltonian H and show that it is constant of motion. Prove or disprove H represents total energy.	07	L_5	CO3
Q.5		**Solve any two.**			
	a)	Find the orbit described by the planet under the inverse square law of attractive force. Classify the orbit on the basis of total energy.	10	L_2	CO4
	b)	Derive Newton's laws of gravitation from Kepler's laws for planetary motion.	10	L_3	CO4
	c)	(i) Show that in case of elliptical orbit, under the central force the two apsidal distances are equal to $a(1-e)$ and $a(1+e)$.	5	L_3	CO4
		(ii) Use Hamilton's equation to find the differential equation for planetary motion and prove that the areal velocity is constant. Assume $f(r) = -\frac{K}{r^2}$.	5	L_3	CO4
Q.6		**Solve any two.**			
	a)	Show that the Jacobian of canonical transformation is unity.	10	L_2	CO5
	b)	Define Poisson bracket of two dynamical variables. For any three dynamical variables u, v & w show that $[u,[v,w]]+[v,[w,u]]+[w,[u,v]]=0$.	10	L_2	CO5
	c)	(i) Test the following transformations for canonical $Q = q^\alpha \cos(\beta p),\ P = q^\alpha \sin(\beta p)$	05	L_4	CO5
		(ii) Test the transformation $P = 2\left(1+q^{1/2}\cos p\right)q^{1/2}\sin p$, $Q = \log\left(1+q^{1/2}\cos p\right)$ for canonical. And hence find generating function.	05	L_4	CO5

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