M.Sc. Physics Semester – 1 Examination

Phys-C-101 - {Classical Mechanics}

Paper Code: 22923

Time: 01 Hrs 30 Min. 17 FEB 2021 Maximum Marks: **42**

Note: Answer **any three** questions. Figures to the right indicate marks allotted.
All symbols have their usual meaning.

Q.1	**a**	Discuss variation technique of calculus, and derive Euler-Lagrange's equation of motion.	**07**
	b	Explain how symmetry property of time leads to the conservation of energy.	**05**
	c	Write two advantages of variation principle over the Lagrange's approach.	**02**
		OR	
Q.1	**a**	State Hamilton's principle and derive Hamilton's equations of motion.	**07**
	b	Determine relation between infinitesimal Canonical transformation and Poisson brackets.	**07**
Q.2	**a**	Derive Hamilton-Jacobi equations. Show that Hamilton's principal function can be written as indefinite time integral of Lagrangian plus a constant term.	**07**
	b	Consider a particle of mass m in a central force field with $H = \frac{1}{2m}\left(p_r^2 + \frac{p_2^2}{r^2}\right) + V(r)$. Using *separation of variables* method, derive an expression for its orbit (i.e. variable φ).	**07**
		OR	
Q.2	**a**	Solve the problem of simple harmonic oscillator using Hamilton-Jacobi equation.	**07**
	b	Write detailed note on action–angle variables technique. Does it useful for non-periodic system?	**07**
Q.3	**a**	Consider a rigid body with one point fixed (≡ origin, say) and rotating with angular velocity $\boldsymbol{\omega}$. Derive an expression for torque acting on the body in *fixed* frame of reference, and hence the Euler's equations of motion. Prove that when torque acting on the body is zero, kinetic energy is conserved.	**07**
	b	Write note on Euler's angles and derive total transformation matrix. Write one property of this transformation matrix.	**06**
	c	Write constraint on the rigid body with one point fixed.	**01**
		OR	
Q.3	**a**	What is inertia tensor? Define inertia tensor for continuous distribution of mass. Give its properties. Classify different types of rotation motion of a top.	**07**
	b	For the case of rigid body, derive expressions for kinetic energy and angular momentum.	**07**
Q.4	**a**	Discuss different types of equilibrium. Expand potential energy about the equilibrium state to lowest order to find matrix relations $V = \frac{1}{2}\boldsymbol{q}^{\dagger}V\boldsymbol{q}$ and $T = \frac{1}{2}\dot{\boldsymbol{q}}^{\dagger}T\dot{\boldsymbol{q}}$. Hence derive $\sum_j\left[T_{jk}\ddot{q}_j + V_{jk}q_j\right] = 0$.	**07**

	b	For the case of two simple pendulums coupled with massless spring, derive expressions for eigen frequencies and eigen vectors.	07
		OR	
Q.4	a	Discuss orthogonality of the eigenvectors describing coupled oscillations. Give importance of normal coordinates in dealing with coupled oscillations.	07
	b	Using two roots ω_s and ω_r of the secular equation $\sum_{j=1}^{n}\left(V_{jk} - T_{jk}\omega^2\right)a_{jk} = 0$, draw your conclusion regarding vector eigen vector $\vec{a}_r$.	06
	c	Write necessary mathematical condition for equilibrium to be unstable.	01