UNIVERSITY OF THE PUNJAB

Part-I : Supplementary Examination 2018

Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: I (Mathematical Methods of Physics)

MAX. TIME: 3 Hrs.
MAX. MARKS: 100

NOTE:Attempt FIVE questions in all, selecting at least TWO questions from each section.

Section I

Q No. 1:

a) A particle is moving in space. Find the expression for its velocity and acceleration in cylinderical coordinates. [10]

b) For spherical polar coordinates (r, θ, ϕ), prove that the unit vectors $\hat{r}, \hat{\theta}, \hat{\phi}$ are mutually orthogonal. [10]

Q No 2:

a) Prove Rodrigue's formula for the Legender Polynomials i.e., $P_n(x) = \frac{1}{2^n n!}\frac{d^n}{dx^n}(x^2-1)^n$

b) For the Legender's Polynomials prove that $P_l(-\omega) = (-1)^l P_l(\omega)$[10+10]

Q.No. 3.

a) Define proper and improper orthogonal transformations.[10]

b) Define inner and outer product of a cartesian tensor. Elaborate your answer by giving two example of each and using the transformation laws of tensors of rank not less than 2. [10]

Q.No.4.

Evaluate

a) $\int_0^{2\pi} \frac{1}{13+12\sin x}dx$ [10]

b) $\int_0^{2\pi} \frac{1}{(2+\cos x)^2}dx$,where $a > b > 0$ [10]

Q.No. 5.

a) Prove the following Cauchy's integral formula for the derivative:

$$f^n(x) = \frac{n!}{2\pi i}\oint_C \frac{f(z)}{(z-a)^{n+1}}dz \text{ ; n=1,2,3,4,.. [10]}$$

b) Evaluate the integral $\oint_C \frac{e^{2z}}{z^4}dz$,where c; $|z|=1$ [10]

Section-II

Q.No. 6.

a) If $f(z) = u + iv$ analytic with derivative $f'(z)$ which is continuous at all points on a simple closed curve 'C', prove that $\oint_C f(z)dz = 0$. [10]

b) Prove Cauchy's theorem for multiple connected region. [10]

Q.No.7.

a) Prove that eigen values of Stum- Liouville (S.L.)problem are real. [10]

b) Find the eigen values and eigen functions of the following S.L. problem

$y'' + \lambda y = 0$, with boundary conditions:

$y(0) + y'(0) = 0$, & $y(1) + y'(1) = 0$ [10]

Q.No. 8.

For the Bessel function , prove that:

a) $xJ_n'(x) = xJ_{n-1}(x) - nJ_n(x)$

b) $\int_0^{\frac{\pi}{2}} J_1(x\cos\theta)\,d\theta = \frac{1-\cos x}{x}$ [10+10]

Q.No.9.

a) Prove that $P_n^0(x) = P_n(x)$, (ii) $P_n^m(x) = 0$, if $m > n$ [10]

b) If $f(z)$ is analytic in a simply connected region,Prove that $\int_a^b f(z)dz$ is independent of the path joining any two points 'a' and 'b' in R. [10]

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Part-I : Supplementary Examination 2018

Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics | **MAX. TIME: 3 Hrs.**

PAPER: II (Classical Mechanics) | **MAX. MARKS: 50**

NOTE:Attempt FOUR questions, selecting at least ONE questions from each section.

SECTION I

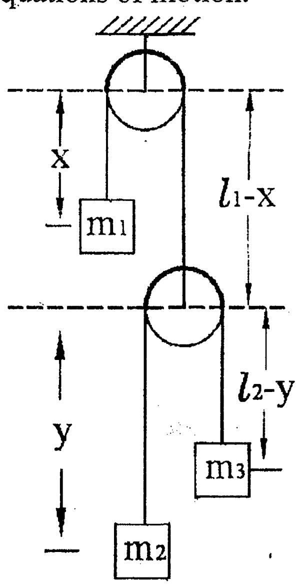
1(a) Show that the time rate of change of total angular momentum of a system of particle is equal to the total external torque.

(b) State D'Alembert's principle and use it to derive Euler-Lagrange equation of motion

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_i}\right)-\frac{\partial T}{\partial q_i}=Q_i.$$

(c) Show that the linear momentum of a system of particles is the same as if a single particle of mass M is located at the position of the center of mass and moving in the manner the center of mass moves. [4,4.5,4]

2(a) Consider the double pulley system as shown in the figure. Use the coordinates indicated, determine the equations of motion.



(b) A particle moves in a plane under the influence of a force $f = -Ar^{\alpha-1}$ directed towards the origin, A and $\alpha > 0$ are constants. Choose appropriate generalized coordinates and let the potential energy be zero at the origin. Find the Lagrange equations. Is the angular momentum about the origin conserved? Is the total energy conserved?

(c) Show that the magnitude R of the position vector of the centre of mass is given by the following equation

$$M^2R^2 = M\sum_i m_i x_i^2 - \frac{1}{2}\sum_{i,j} m_i m_j x_{ij}^2$$ [4,4.5,4]

3(a) A point particle moves in space under the influence of a force derivable from a generalized potential of the form $U(r,v)=V(r)+\sigma \bullet L$, where r is the radius vector from a fixed point, **L** is the angular momentum about that point and σ is a fixed vector in space. Find the components of the force on the particle in both Cartesian and spherical polar coordinates.

(b) Assume Earth's orbit to be circular and the Sun's mass suddenly decreases by half. Write orbit does Earth then have? Will Earth escape the solar system?

P.T.O.

(c) Discuss the properties of motion in the central force field by distinguishing the bound and unbound states. [4.5,4,4]

4(a) A sphere of radius ρ is constrained to roll without slipping on the lower half of the inner surface of the hollow cylinder of inside radius R. Determine the Lagrange function, the equation of constraint and Lagrange's equation of motion. Find the frequency of small oscillation. [4,4,4.5]

(b) Show that the path followed by a particle in sliding from one point to another under the action of gravity in the absence of friction and in the shortest time is a cycloid.

(c) Show that geodesic on the surface of a sphere is a segment of a great circle.

SECTION II

5(a) Show that, if a transformation from (q, p) to (Q, P) be canonical then the bilinear form $\sum_i (\delta p_i dq_i - \delta q_i dp_i)$, remains invariant.

(b) Show that the transformation $P = q \cot p$, $Q = \log\left(\frac{\sin p}{q}\right)$, is canonical and also show that the corresponding generating function is

$$F = e^{-Q}\left(1 - q^2 e^{2Q}\right)^{\frac{1}{2}} + q \sin^{-1}\left(q e^{Q}\right).$$

(c) Define Poisson bracket and show that the Poisson brackets are invariant under the canonical transformation. [4,4,4.5]

6(a) The Lagrangian for a free particle in terms of paraboloidal coordinated $(\varsigma, \eta, \varphi)$ is $L = \frac{1}{2} m\left(\varsigma^2 + \eta^2\right)\left(\dot{\varsigma}^2 + \dot{\eta}^2\right) + \frac{1}{2} m \varsigma^2 \eta^2 \dot{\varphi}^2$. Find the momenta conjugate to $(\varsigma, \eta, \varphi)$ and also the Hamiltonian.

(b) State Hamilton's principle of least action and use it to derive Hamilton's equations of a dynamical system.

(c) Show that if A(q, p) and B(q, p) be any two integrals of motion of a dynamical system, their Poisson bracket is also an integral of motion. [4,4,4.5]

7(a) Show that the phase space volume of a canonical system is independent of time (Liouville's Theorem).

(b) Define action-angle variable (J_i, ω_i). Show that the action-angle variables obey the following equations:

$$\dot{J}_i = -\frac{\partial H(J_i)}{\partial \omega_i} = 0, \quad \omega_i = \frac{\partial H(J_i)}{\partial J_i}$$

Also show that the change in the variable ω_i by changing q_i is given by

$$\Delta_i \omega_j = \delta_{ij}$$ [6, 6.5]

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Part-I : Supplementary Examination 2018

Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics **MAX. TIME: 3 Hrs.**

PAPER: III (Quantum Mechanics) **MAX. MARKS: 100**

NOTE:Attempt FIVE questions, selecting at least ONE questions from each section.

SECTION – I

Q 1 . (a)Prove that the eigen values of a Hermitian operator are always real.

(b)State Correspondence principle. (14+6)

Q 2 . (a) Write down the expression for the Hamiltonian of a one – dimensional simple harmonic oscillator .

(b) If $\hat{a} = \frac{1}{\sqrt{2m\hbar\omega}}(i\,p + m\omega\,x)$ and $\hat{a}^{+} = \frac{1}{\sqrt{2m\hbar\omega}}(-i\,p + m\omega\,x)$ then prove that

$[\hat{a}, \hat{a}^{+}] = 1$

(c) Also prove that $\hat{H} = \hbar\omega\,(\hat{a}^{+}\hat{a} + 1/2)$

(2+12+6)

Q 3 . (a) A Simple Harmonic Oscillator is in a state given by

$\Psi = 1/\sqrt{3}\,\Psi_0 + \sqrt{2/3}\,\Psi_1$

where Ψ_0 and Ψ_1 are ground and excited states of S.H.O.

What is probability of finding

(i) value $\hbar\omega/2$ in the state Ψ (ii) value $3\hbar\omega/2$ in the state Ψ

(b) State and prove Ehrenfest's theorem. (6+14)

SECTION – II

Q 4 .(a) A particle of mass m and total energy $E > V_0$ strikes a potential step from left .Where

$V(x) = 0$ for $x < 0$

$V(X) = V_0$ for $x \geq 0$

Calculate the reflection and transmission coefficients. Also show that the sum of reflection and transmission coefficients is equal to one.(R+T=1) (20)

P.T.O.

5 .(a) Obtain eigen value spectrum of $\hat{L}_z$.

(b) Given that in spherical polar coordinates $\hat{L}_z = -i\hbar \frac{\partial}{\partial \phi}$, show that

$$[\hat{L}_z , \cos\phi] = i\hbar \sin\phi \quad \text{and} \quad [\hat{L}_z , \sin\phi] = -i\hbar \cos\phi$$

(c) Z–component of angular momentum and azimuthal angle ϕ can be measured with precision at same time or not ? (8 +8+4)

6 .(a)State and explain Generalised Pauli Principle. Write normalized wave funtions for fermions and bosons?

(b)Write down $\Psi(1,2,3)$ for a set of three identical fermions. Show that if any two of these identical Fermi particles are in same state then the wave function vanishes. (10+5+5)

SECTION – III

7 .(a)Derive the first order corrections to energy levels in non degenerate time independent perturbation theory. (20)

8 .(a)Write down (do not derive) the expression for the wave function known as the WKB approximation for both, $E > 0$ and $E < 0$. Apply it to the case of an infinite square well

$$V(x) = 0 \text{ for } 0 < x < a$$

$$= \infty \quad \text{otherwise}$$

To obtain the energy eigen value spectrum. (20)

9 .(a) Let A and B be two non commuting operators. Let **ΔA** and **ΔB** be the uncertainties in the measurement of **A** and **B** respectively.

(b)Show that

$$(\Delta A)^2 (\Delta B)^2 \geq (1/2i \ \langle [A, B] \rangle)^2$$

Verify that $(\Delta x)(\Delta p_x) \geq \hbar/2$,where x and p_x are the position and momentum variables respectively. (14+6)

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Part-I : Supplementary Examination 2018

Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: IV (Solid State Physics-1)

MAX. TIME: 3 Hrs.
MAX. MARKS: 50

NOTE:Attempt FOUR questions, selecting at least ONE questions from each section.

Section- 1

Q.1 What do you mean by crystal system? What are the parameters that define a crystal system in three dimensions. Define seven crystal system in three dimensions and describe the Bravias lattices in each system. (12.5)

Q.2. (a) Explain the crystal structure of Sodium Chloride in detail. (5)

(b) Consider (hkl) plane in a crystal system, prove that the reciprocal lattice vector $G = hb_1 + kb_2 + lb_3$ is perpendicular to this plane and the distance between two adjacent parallel planes of lattice is $d_{hkl} = 2\pi/|G|$ (7.5)

Q.3 (a) Derive the Bragg law in the reciprocal lattice and then derive the Laue equation, also explain the geometrical interpretation of the Laue equations. (9)

(b) Explain the Ewald construction in the reciprocal lattice. (3.5)

Q.4 (a) Considering solid as a continuous medium, define stress and strain. Derive expressions for stress and strain components and then explain how these are reduced to six components in each case. (8.5)

(b) Define the elastic compliance and elastic stiffness constants with their respective units. (4)

Section- 11

Q.5 Derive the dispersion relation of phonons in a monatomic crystal, sketch it in the first Brillion zone and also discuss it under the long wavelength limit. (12.5)

Q.6 Differentiate between following. (4+4.5+4)

i) Schottky and Frenkel defects

ii) Edge and Screw dislocations

iii) F- centres and V- centres

Q.7 Write notes on the following. (6+6.5)

i) The Diamond structure

ii) Ficks law of diffusion in solids

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Part-I : Supplementary Examination 2018

Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics **MAX. TIME: 3 Hrs.**

PAPER: V (Electronics) **MAX. MARKS: 100**

NOTE: Attempt FIVE questions, selecting at least ONE questions from each section.

	Section I	
Q.1	**(a)** Draw the circuit of full wave (bridge) rectifier with a capacitor filter and find the expression for ripple factor and V_{dc} in it.	**10**
	(b) A full wave rectifier with capacitor filter, with f = 50 Hz, I_{dc} = 100 mA and V_{dc} = 25 V at full load **(i)** What value of C is needed to limit the ripple factor to 0.01(1%)? **(ii)** What should V_{rms} be?	**8**
	(c) What is the Peak reverse voltage? What is the PRV for each diode in full-wave (center tapped transformer) rectifier circuit.	**2**
Q.2	**(a)** Draw the h-parameter equivalent circuit of Common Collector transistor amplifier and find the expression for voltage gain, current gain, input and output resistances.	**10**
	(b) A pnp transistor with the following parameters is employed in a Common Emitter amplifier; R = 2 KΩ, h_{ie} = 900 Ω, h_{fe} = 25, and h_{oe} = 16 x 10^{-6} mho. Calculate g_m, A_v, A_i, R_i, R_o and power gain in dB.	**8**
	(c) If α (alpha) is given, how do you determine h_{fe} (β).	**2**
Q.3	**(a)** Draw the circuit of voltage-feedback bias network and find the relation for Its collector current and stabilizing ratio.	**10**
	(c) Determine the design values for voltage feedback bias circuit with V_{CC} = 18V, I_C = 2.3 mA, h_{fe} = 75, V_{BE} = 0.7V, V_{CE} = 0.5V_{CC}, I_B = 30μA. Assume missing data.	**10**
	Section II	
Q.4	**(a)** What are construction differences in JFET and MOSFET?	**4**
	(b) Explain the construction and working of n-channel MOSFET in Depletion mode.	**10**
	(c) Describe how pinch-off is obtained in an n-channel JFET.	**6**
Q.5	**(a)** Discuss the low frequency response of RC coupled amplifier and find the expression for $A_{v(low)}$ and phase angle θ.	**10**
	(b) If R_E is un bypassed in CE then find the expression for A'_V.	**5**
	(c) Why f_1 and f_2 are called half power frequencies?	**5**
Q.6	**(a)** Draw the equivalent circuit of voltage-shunt feedback circuit, derive the expression for feedback factor β and voltage gain with feedback.	**8**
	(b) Prove that the nonlinear distortion in amplifier has been reduced by using the negative feedback.	**6**
	(c) An amplifier has internal gain of 37 dB and at 50V output has 11% distortion. Feedback is applied to reduce the distortion to 1%. What gain will be obtained?	**6**
	Section III	
Q.7	**(a)** Draw the circuit of practical Hartley oscillator. Find the relation for its frequency.	**10**
	(b) In a Colpitts oscillator C_1 = 300 pF, C_2 = 150 pF and L = 100 μH. What is the frequency of oscillation?	**5**
	(c) Write the Boolean equation, symbol, truth table and DTL circuits of NAND and NOR logic gates.	**5**
Q.8	**(a)** How power amplifiers are classified.	**5**
	(b) Prove that the efficiency of class A power amplifier is nearly 50 %.	**10**
	(c) Calculate the second harmonic distortion when i_{max} = 0.9A, i_{min} = 0.47A I_C = 0.65 A and load R = 100 Ω.	**5**
Q.9	Write a note on any **two** of the following. **(i)** Diode clipper and clamper circuits. **(ii)** R-C phase shift oscillator. **(iii)** Astable multivibrator	**10 + 10**