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M.Sc. DEGREE EXAMINATION, DECEMBER 2016.

First Semester

Physics

Paper I — MATHEMATICAL PHYSICS

(Regulation 2012)

Time: Three hours

Maximum: 70 marks

Answer ALL questions.

Allower ALLI questions.

Using Hermite polynomial prove that $\int_{-\infty}^{\infty} e^{-x^2} H_n(x) H_m(x) dx = 2^x n! \sqrt{n} S_{nm}.$

Prove that recurrence relation of Hermite polynomial $H_n^{-1}(x) = 2nH_{n-1}(x), n > 1$ where $H^1(x) = 0$.

Or

(c) Discuss orthogonality of Bessel's functions of first kind.

(d) Prove that
$$\int_{1}^{1} P_{n}(x)P_{m}(x)dx = \frac{2}{2n+1}S_{nm}.$$

- 2. (a) Define Lapalce transform and explain the properties of Inverse Laplace transform.
 - (b) Find $L\{e^{-3t} \sin 2t\}$.

- (c) Obtain the Laplace transform of a derivative.
- (d) Find the inverse laplace transform of $\frac{1}{s^2(s^2+a^2)}.$
- 3. (a) Bring out the relation between fourier transform and Laplace transform.
 - (b) Find the fourier series of a triangular wave represented by

$$f(x) = \begin{cases} x & \text{for } 0 < x < \pi \\ -x & \text{for } -\pi < x < 0 \end{cases}$$

Or

- (c) Explain the Half-Wave expansions in Fourier series.
- (d) Explain FT of delta function.
- 4. (a) Prove that $u = e^{-\lambda}(x \sin y y \cos y)$ is harmonic and find ν such that $f(z) = u + i\nu$ is analytic.
 - (b) Expand $f(x) = \sin z$ in a Taylor series about $z = \pi/4$.

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- (c) State and explain Laurent's theorem.
- (d) Evaluate $\int_{0}^{1} \frac{x^{2}}{1+x^{4}} dx$ by contour integration.
- 5. (a) Define contravariant, covariant and mixed tensors giving suitable examples.
 - (b) If A_r^{pq} and B_r^{pq} are tensors prove that $C_{rl}^{pqs} = A_r^{pq} B_l^s$ is also a tensor.

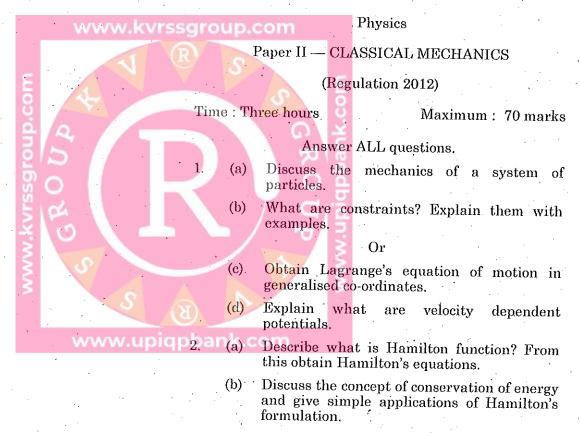
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- (c) State and explain quotient law of tensor.
- (d) Show that the kronecker delta function is a mixed tensor of rank two.

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- Obtain equivalent one dimensional potential for inverse square law of force and obtain the nature of orbits for bounded motion.
- Obtain the differential equation for the orbit and discuss integrable power law potentials.

- Give an explanation of Euler angles in rigid (a) body rotation.
 - Discuss angular momentum and show how it depends on inertia tensor.

3. Derive Lagrange's (a) equations from variational Hamilton's principle.

Explain some simple applications Hamilton's principle.

Or

- Discuss equations canonical of transformations. Give examples of canonical transformations.
- Explain conservation theorems in poisson bracket notation.
- Obtain Hamilton's principal function in terms of the Lagrangian.
 - Explain what is Hamilton's characteristic function and discuss its significance.

Or

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- Explain what you understand by action (c) angle variables.
- Obtain the solutions of a coupled oscillator and discuss its properties in terms of normal co-ordinates.

Or

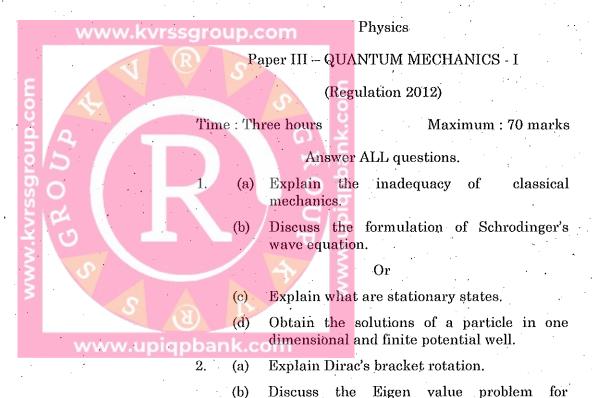
- Give an account of torque-free motion of a rigid body.
- Explain Corialis force.

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Or

continuous spectrum.

operators. Explain what is meant by

- (c) What is a Hermitian operator. Explain the properties of Hermitian operators.
- (d) Explain Schmidt orthogonalisation procedure.
- 3. (a) Express L_x , L_y and L_z in cartesian coordinates and spherical polar co-ordinates.
 - (b) Obtain the eigen values and eigen functions of L^2 and L_z in spherical polar co-ordinates.

- (c) What is a rigid rotator. Write its Schrodinger wave equation in spherical polar co-ordinates and obtain its eigen values and eigen functions.
- (d) With a neat diagram explain the hydrogenic orbitals and discuss their redial probability density.
- 4. (a) Explain time independent perturbation theory for a degenerate case.
 - (b) Discuss how it can be used to explain linear stark effect in hydrogen atom.

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- (c) Using variation method show how the ground state of the atom can be obtained.
- (d) Briefly discuss WKB method and explain its application.

- 5. (a) Explain the formalism of time dependent perturbation theory.
 - (b) Assuming Harmonic perturbation discuss the transition to continuum states.

Or

- Describe the nature of Einstein's coefficients for spontaneous and stimulated emissions.
- (d) Obtain the selection rules for spectroscopic transitions.

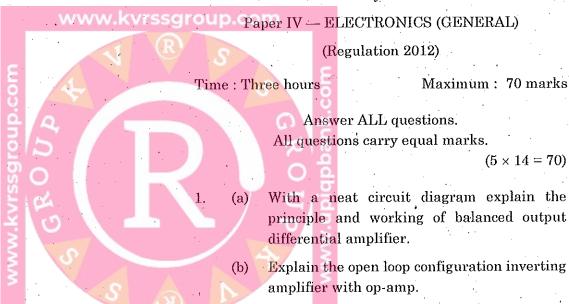
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(c) Explain the effect of feedback on closed loop gain input resistance and output resistance of op-amp.

Or

(d) Discuss the oppset voltage and bandwidth of an op-amp.

- 2. (a) Explain briefly the method of CMRR measurement in an op-amp.
 - (b) Explain how op-amp used an integrator and differentiator.

- (c) With a neat circuit diagram explain the working of phase shift oscillator.
- (d) What is multivibrator? Explain the working of a stable multivibrator with a neat diagram.
- 3. (a) What is amplitude modulation? Explain the generation of AM waves.
 - (b) Define DSBSC modulation and explain the coherent detection of DSBSC waves.

Or

- (c) What is meant by SSB modulation? Explain the detection of SSB waves.
- (d) With a neat circuit diagram explain the working of FDM.
- 4. (a) Explain the operation of eight input multiplexer.
 - (b) Draw the circuit diagram to implement a three-variable logic function, with the following sum-of-products expression, using eight input multiplexer $Z = A\overline{B} \, \overline{C} + \overline{A} \, B \, \overline{C} + ABC.$

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- (c) What is flip-flop? Explain the working of JK flip-flop with a necessary diagram.
- (d) Draw the cascade counter and explain its operation.
- 5. (a) Draw the architectural diagram of 8085 CPU and explain each part in it.
 - (b) What is stack? Explain the working of stack in 8085 based system using PUSH and POP operations.

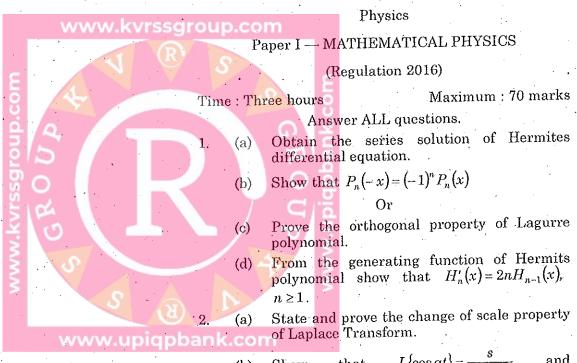
Or-

- (c) Explain the architecture and pin description of 8051 microcontroller.
- (d) Write an assembly language program to find the largest number in 9 given series of 8-bit numbers.

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(b) Show that
$$L(\cos at) = \frac{s}{s^2 + a^2}$$
 and

$$L\{\sin at\} = \frac{a}{s^2 + a^2}.$$

Or

- (c) Obtain the Laplace Transform of derivative.
- (d) Using Laplace Transform of derivative find the Laplace Transform of $F(t) = t^2$.
- 3. (a) Define periodic function and obtain the expressions for Fourier coefficients.
 - (b) Explain about Half-Wave expansions in Fourier series.

- (c) Find the Fourier series for the function $f(x) = x^2$ for $-\pi \le x \le \pi$.
- (d) Find the $\sin e$ and \cos Fourier Transform of $x^n e^{-cx}$.
- 4. (a) State and prove Cauchy's theorem.
 - (b) Evaluate $\oint_C \frac{e^{2x}}{(z+1)^4} dz$, where C is a circle |z|=3.

Or

- (c) State and explain Taylor's theorem.
- (d) Find the residue of $f(z) = \frac{z^2 2z}{(z+1)^2(z^2+4)}$.

- 5. (a) Explain about contravariant and covariant tensors with examples.
 - (b) Explain the addition of tensors.

Or

- (c) Explain the quotient Law of tensor.
- (d) Show that the covariant derivatives of fundamental tensors vanish.

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First Semester www.kvrssgroup.com **Physics** Paper II - CLASSICAL MECHANICS (Regulation 2016) Maximum: 70 marks Time: Three hours Answer ALL questions. What are constraints? Explain with suitable examples. State and prove the conservation theorem for total angular momentum of a system of particles. www.upiqpbank.com Or

- State and prove D'Alembert's principles. (c)
- Derive Lagrange's equation of motion from (d) -D'Alembert's principle.

- 2. (a) Explain the conservation theorems and symmetry properties of H.
 - (b) What is first integral and obtain the equation of motion?

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- (c) Explain the conditions for closed orbits.
- (d) Discuss briefly the problem of scattering in a central force field.
- 3. (a) Obtain Lagrange's equations from variational principle.
 - (b) Explain principle of least action.

Or

- (c) Define canonical transformation. Show that the canonical transformation form a group.
- (d) Show that the poisson bracket is invariant under canonical transformation.
- 4. (a) Explain Hamilton-Jacobi theorem.
 - (b) Find the amplitude of a harmonic oscillator using Hamilton-Jacobi theorem.

Or

- (c) What are normal coordinates and normal modes? Explain.
- (d) Obtain the normal coordinates for a linear triatomic molecule.

- 5. (a) With a neat diagram, explain Euler's angles.
 - (b) Obtain an expression for the angular velocity of a rigid body in terms of Euler's angles.

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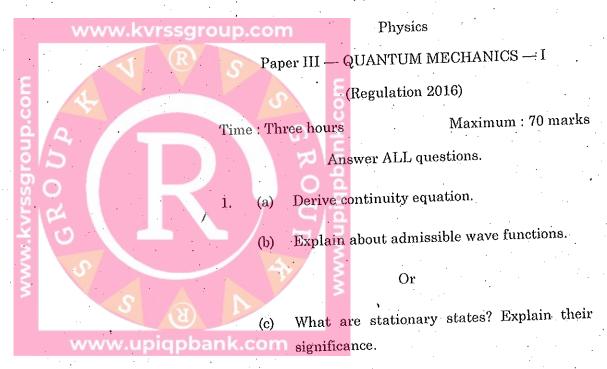
- (c) Explain the torque-free motion of a rigid
- (d) State and explain coriolis effect.

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(d) Derive Schroedinger equation of motion for one dimensional harmonic oscillator.

- 2. (a) Discuss Dirac's bra are ket rotations.
 - (b) Prove that eigen vectors belonging to the different eigen values are orthogonal.

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- (c) What are Hermitian operators? Explain their significance.
- (d) Explain the orthogonalization procedure.
- 3. (a) Express the angular momentum operators in spherical polar coordinates.
 - (b) Prove that the operators L^2 and L_z commute and the operators L_x and L_y do not commute.

Or

- (c) Obtain the eigen values of a rigid rotator.
- (d) Show that $[L_z, L_+] = \hbar L_+$ and $[L^2, L_-] = 0$.
- 4. (a) Discuss the time-independent perturbation theory for degenerate system.
 - (b) Discuss the linear stark effect in hydrogen atom.

Or

- (c) Using the variation method obtain the ground state energy of Helium atom.
- (d) Discuss the WKB method.

- 5. (a) Describe the salient features of tim dependent perturbation theory.
 - (b) Obtain Einstein transition probabilities using this theory.

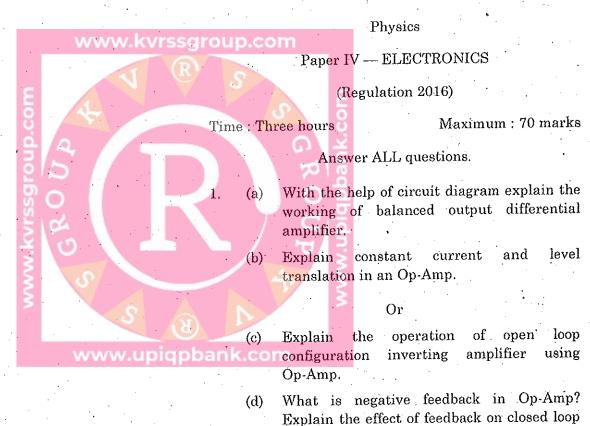
Or

- (c) Explain the interaction of an atom with electromagnetic radiation.
- (d) Briefly explain sudden and adiabatic approximations in quantum mechanics.

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gain input resistance.

- 2. (a) Write a note on CMRR frequency response in Op-amp.
 - (b) Explain how Op-amp can be used as integrator and differntiator.

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- (c) Explain the working of phase shift oscillator and get expression for frequency stability.
- (d) What is multivibrator? Explain the working of monostable multivibrators.
- 3. (a) Distinguish between AM and DSBSC modulation.
 - (b) Explain the generation of DSBSC waves,

Or

- (c) Define what is meant by SSB modulation?

 Describe a method for the detection of SSB waves.
- (d) Write a note on FDM.
- 4. (a) With a neat circuit diagram explain the working of multiplexer.
 - (b) Explain the applications of demultiplexer.

Or

- (c) Draw the functional diagram of RS Flip-Flop and explain its working with truth table.
- (d) Explain the working of shift register.

- 5. (a) Draw the functional block diagram of 8085 microprocessor and explain it.
 - (b) Explain the addressing modes of 8085 microprocessor.

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- (c) Write an assembly language program to find the largest number is an array.
- (d) Explain the interfacing devices of 8085.

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