D 13160 **(Pages : 3)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 1C 04—ELECTRONICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

8 *Short questions answerable within 7½ minutes.*
Answer **all** *questions, each carry weightage* 1.

1. How is digital switching done using MOSFET ?
2. Give the basic principle of the working of Light dependent resistor (LDR). Mention its application.
3. Define the term CMRR and explain what will be the condition for CMMR to infinite.
4. Differentiate between wide band reject filter and narrow band reject filter.
5. What are ripple counters ? Give its advantages.
6. Give the principle of working of an IR emitter. Mention two uses.
7. What are the functions of an accumulator ?
8. Give two characteristics of a non-inverting amplifier.

(8 × 1 = 8 weightage)

Turn over

Section B

4 essay questions answerable within 30 *minutes.*

Answer any **two** *questions, each carry weightage* 5.

9. Explain the working of MOSFET under depletion mode. Also explain the working of enhancement type MOSFET.

10. Explain the construction and operation of semiconductor lasers.

11. What are Butterworth filters ? Explain the design and working of a first order low-pass and high pass filters using op-amp.

12. Explain the internal architecture of 8085 microprocessor.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 *minutes.*

Answer any **four** *questions, each carry weightage* 3.

13. For a light emitting diode made of GaAsP, the energy gap is 1.90 eV. What is the wavelength of radiations emitted ? Are these radiations visible radiations ? Take $h = 6.6 \times 10^{-34}$ Js.

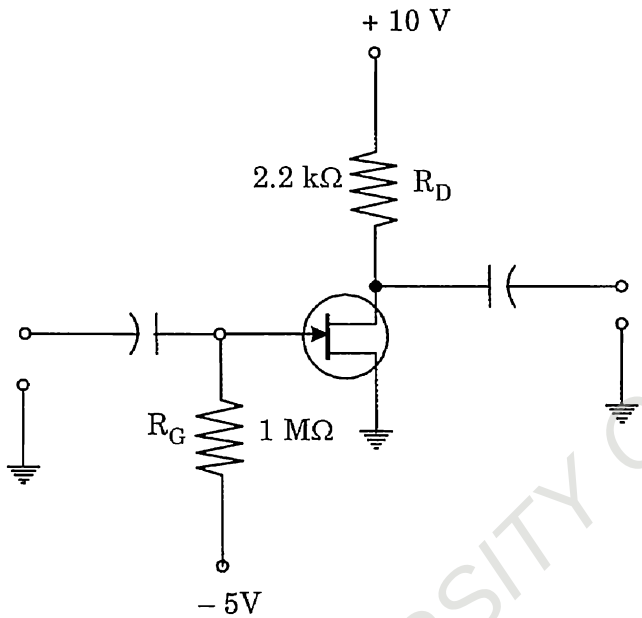
14. Explain narrow band-pass filter. Design a narrow band-pass filter so that

    $f_c = 1$ kHz, Q = 3, $A_F = 10$.

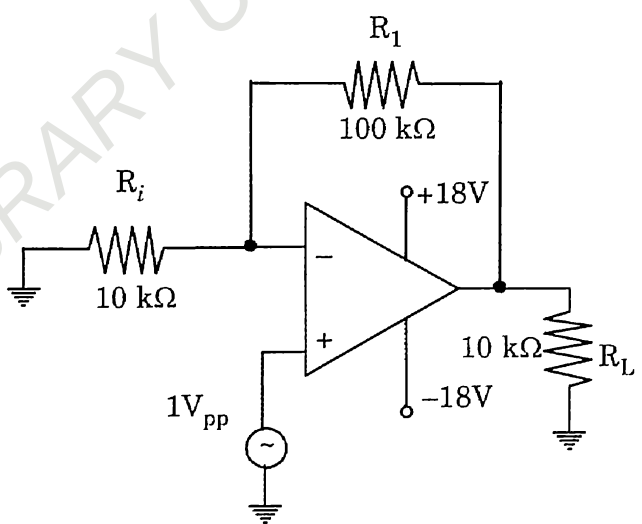
15. A power amplifier has a power gain of 40 db. If an input power of 3 mW is applied, then calculate the output power.

16. Design a second order low-pass filter for a cut-off frequency 1 kHz (C = 0.01 μF).

17. JFET in given Figure has values of $V_{GS\ (off)} = -8V$ and $I_{DSS} = 16$ mA. Determine the values of V_{GS}, I_D and V_{DS} for the circuit :



18. For the noninverting amplifier circuit shown in Figure, find (i) Closed loop voltage gain ; and (ii) Maximum operating frequency. The slew rate is 0.5 V/μs.



19. Describe master slave JK flip-flop.

(4 × 3 = 12 weightage)

D 13159 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 Short questions answerable within 7.5 minutes)

Answer **all** *questions.*

Each carry weightage 1.

1. Explain the loss tangent of a medium. How do we define a good conductor in a time varying field ?
2. Define reflection coefficient and transmission coefficient. Obtain the relation between them.
3. Explain the term skin depth. How does it vary with wavelength ?
4. State the boundary conditions to be satisfied by H_z for TE waves in a rectangular waveguide.
5. Define the quality factor of a cavity resonator.
6. Express the field tensor in terms of four-vector potential.
7. What is meant by plasma frequency ? Give the expression.
8. Explain the krook collision term.

(8 × 1 = 8 weightage)

Turn over

Section B

(4 essay questions answerable within 30 minutes)
Answer any **two** *questions.*
Each carry weightage 5.

9. Derive the homogeneous electromagnetic wave equations in a source free region ?

10. Obtain the general transmission-line equations for arbitrary time dependence and for time-harmonic time dependence ?

11. Derive the general transformation rules for electromagnetic field.

12. Derive the fluid equation of motion in isotropic case.

(2 × 5 = 10 weightage)

Section C

(7 problems answerable within 15 minutes)
Answer any **four** *questions.*
Each carry weightage 3.

13. Obtain the boundary conditions between a lossless dielectric and a perfect conductor.

14. Prove that a uniform plane wave propagating in an arbitrary direction $\hat{a}$, is a TEM wave with E perpendicular to H and that both E and H are normal to $\hat{a}$.

15. A narrow-band signal propagates in a lossy dielectric medium which has a loss tangent 0.12 at 500 kHz, the carrier frequency of the signal. The dielectric constant of the medium is 2. Calculate the phase and group velocity ?

16. A signal generator having an internal resistance 1 Ω and an open circuit voltage $v(t) = 0.03\cos(2\pi(10^6)t)$ is connected to a 48 Ω lossless transmission line. If the velocity of wave propagation on the line is 10^8 (m/s), find the instantaneous expressions for the voltage and current at an arbitrary location on the line. Find the average power transmitted to the load ?

17. Derive the continuity equation in tensor form.

18. Compute the Larmor radius for a solar proton streaming with velocity 240 km/s in a magnetic field of (5×10^{-5}) Tesla ? What does its value for a 1.1keV He^+ ion in the same field ?

19. Compute λ_D and N_D in a fusion reactor with capacity of ion concentration from $10^{13}/m^3$ to $10^9/m^3$ and at kT_e 0.01eV.

(4 × 3 = 12 weightage)

D 13158 (Pages : 3) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY IC 02—MATHEMATICAL PHYSICS—1

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

8 *Short questions answerable within 7½ minutes.*
Answer **all** *questions, each carry weightage* 1.

1. If V represents a vector derive the curl of V in orthogonal curvilinear coordinates.
2. Is the given matrix Hermitian $\begin{bmatrix} 1 & -i & -3i \\ i & 5 & 0 \\ 3i & 0 & 2 \end{bmatrix}$.
3. Explain concept of outer product in tensors.
4. With an example explain features of a hyperbolic partial differential equation.
5. Show that $\int_{-1}^{+1} xP_n(x)\, p_{n-1}(x)\, dx = \frac{2n}{4n^2-1}$.

6. Explain the convolution theorem of Fourier transform.

7. Explain when can a second-order linear homogeneous differential equation can be called self-adjoint.

8. Distinguish between Fourier integral and Fourier transform.

(8 × 1 = 8 weightage)

Section B

4 essay questions answerable within 30 *minutes.*
Answer any **two** *questions, each carry weightage* 5.

9. What are orthogonal curvilinear co-ordinate systems ? Obtain the mathematical expression for divergence in terms of curvilinear coordinates.

10. Using appropriate differential equation explain Laguerre polynomials and associated Laguerre polynomials. Obtain their representation in series form.

11. Explain the following properties of Fourier series: (1) Convergence (2) Integration ; and (3) Differentiation. Obtain the sine and cosine series in the interval $(0, \pi)$ for a function $f(x)$.

12. Explain the Frobenius' method of finding solution to homogenous differential equation of second order.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 *minutes.*
Answer any **four** *questions, each carry weightage* 3.

13. Is the given matrix orthogonal $\begin{vmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{vmatrix}$.

14. Prove that $P_{2m+1}(0) = 0$.

15. A string of length n is stretched until the wave speed is 40 m/sec. It is given an initial velocity of 4 sin (x) from its initial position. What is location of maximum displacement ?

16. Evaluate $\Gamma\left(-\frac{1}{2}\right)$.

17. Evaluate Laplace transform of $\frac{\cos\sqrt{t}}{\sqrt{t}}$.

18. Prove that $H_{2n}(0) = (-1)^n \frac{(2n)!}{n!}$.

19. Expand the function $f(x) = \sin x$ as a cosine series in the interval $(0, \pi)$

(4 × 3 = 12 weightage)

D 13157 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHYIC01—CLASSICAL MECHANICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 Short questions answerable within 7.5 minutes)

Answer **all** *questions.*
Each carries weightage 1.

1. State d' Alembert's principle.
2. Define Poisson bracket of two variables and discuss its important properties.
3. Distinguish between Centrifugal and Coriolis forces
4. Define normal frequency and discuss its significance.
5. What are limit cycles ? Distinguish between stable limit cycle and semistable limit cycle.
6. What is chaos ? How does it arise ?
7. Explain different types of constraints.
8. What are canonical transformations ? What is the use of using canonical transformation?

(8 × 1 = 8 weightage)

Turn over

Section B

(4 essay questions answerable within 30 minutes)

Answer any **two** *questions.*
Each carry weightage 5.

9. Explain bow action angle variables can be used to find frequencies of periodic motion in Kepler problem.
10. Discuss the precisional motion-with and without rotation of a spinning top under gravity.
11. Find the frequencies of free vibrations of a linear triatomic symmetric molecule.
12. Discuss Pitch Forck bifurcation, period of doubling and fixed points with respect to logistic Map.

(2 × 5 = 10 weightage)

Section C

(7 problems answerable within 15 minutes)

Answer any **four** *questions.*
Each carry Weightage 3.

13. In the absence of external torque on a body, prove that : (i) The kinetic energy is constant ; and (ii) The magnitude of the square of the angular momentum (L 2) is constant.
14. A bead of mass m slides freely on a frictionless circular wire of radius a that rotates in a horizontal plane about a point on the circular wire with a constant angular velocity ω. Find the equation of motion of the bead by Lagrange's method. Also show that the bead oscillates as a pendulum of length = $\frac{g}{\omega^2}$.
15. Using Lagrange's method of undetermined multiplier, find the equation of motion and force of constraint in the case of a simple pendulum.
16. Using the Poisson bracket, show that the transformation $q = \sqrt{2P}\sin Q$, $p = \sqrt{2P}\cos Q$ is canonical.
17. Find Lagrange's equation of motion of the bob of a simple pendulum.
18. Obtain the Hamiltonian of a charged particle in an electromagnetic field.
19. Show that the transformation $p = m\omega q \cot Q$ and $P = \frac{m\omega q^2}{2\sin^2 Q}$ is canonical. Also obtain the generating function for the transformation.

(4 × 3 = 12 weightage)

D 12933 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2021

(CUCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2017 to 2018 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all twelve** *questions.*
Each question carries 1 *weightage.*

1. State and explain Stoke's theorem in vector calculus.
2. Explain the significance of Maxwell's displacement current.
3. Distinguish between group velocity and phase velocity. Under which conditions they are equal ?
4. State and explain Poynting theorem.
5. Explain why TEM mode cannot be propagated through a wave guide.
6. Compare cavity resonators with LCR resonant circuits.
7. What is four vector ? Write down the equation of continuity in four vector form.
8. Write down Maxwell's equations in covariant form.
9. What is electro magnetic field tensor ?
10. Explain Debye shieding.
11. Explain the quasi neutrality of plasma.
12. Mention any four application areas of plasma physics.

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

13. Discuss the propagation of monochromatic plane waves in conducting media. Derive an expression for skin depth.
14. Distinguish between TEM, TE and TM waves. Discuss the propagation of TE waves in wave guide. Derive an expression for cut off frequency.

Turn over

15. Derive the potential formulation of Maxwell's equations. Express them in relativistic covariant form.

16. Derive fluid equations as the moment of Boltzman equation satisfied by the velocity distribution function f (r, v, t).

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

17. Calculate the percentage of optical energy reflected and transmitted at air to silver interface given that conductivity = 6×10^7 $(\Omega\ m)^{-1}$ at angular frequency (ω) = 4×10^{15} Hz and 1 MHz assuming permeability of silver is equal to that of air.

18. A 5 GHz plane wave is propagating in a material of $\varepsilon r = 2.53$, $\mu_r = 1$ and $\sigma = 0$. Assuming that electric field is given by $E = 10 \cos (10^9\ \pi\ t - \beta z)\ a_x$ (V/m). Determine u, λ and β.

19. A typical rectangular wave guide has dimensions 23 mm and 10 mm. Assuming that it is air filled and the frequency of its operation is 25 GHz list all its TM modes.

20. Show that Lorentz transformation is an orthogonal transformation.

21. Show that $E^2 - c^2B^2$ is Lorentz invariant.

22. Derive an expression for plasma frequency.

(4 × 3 = 12 weightage)

D 12932 **(Pages : 3)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2021

(CUCSS)

Physics

PHY 1C 02—MATHEMATICAL PHYSICS—I

(2017 to 2018 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*
Each question carries weightage 1.

1. Derive expression for gradient in curvilinear co-ordinate system.
2. Evaluate ∇r^n.
3. What are Hermitian matrices ? Mention important properties and give one example.
4. Explain similarity transformations.
5. With suitable example, explain contraction in tensors.
6. Write a note on Levi-Civita symbol.
7. Explain Fuchs' theorem.
8. Explain the concept of singular points and discuss the nature of singularity of Bessel differential equation.
9. Define Wronskian. Explain its significance.
10. Define a beta function. How it is connected to gamma function ?
11. State and explain convolution theorem for Laplace transform.
12. Write note on spherical harmonics.

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*
Each question carries weightage 6.

13. Derive expression for Curl in general curvilinear co-ordinate system. Hence deduce it for spherical polar co-ordinate system.

14. Prove that necessary and sufficient condition for a matrix A to be diagonalizable is that its Eigen vectors are all linearly independent. Reduce the matrix $A = \begin{bmatrix} 5 & 4 & -4 \\ 4 & 5 & -4 \\ -1 & -1 & 2 \end{bmatrix}$ to be in diagonal form.

15. Develop a method to find solution of a second order differential equation and apply this for finding solution of Legendre differential equation.

16. What are the properties of Fourier transform. Apply Fourier transform technique to find solution of one dimensional wave equation with initial conditions,

$Y(x,0) = f(x)$

$\left.\frac{\partial y(x,t)}{\partial t}\right|_{t=0} = 0.$

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

17. Find unit vectors in Spherical polar co-ordinate system. Show that the Spherical polar co-ordinate system is orthogonal.

18. Define an orthogonal matrix. Prove that the matrix $A = \begin{bmatrix} 1/3 & -2/3 & 2/3 \\ 2/3 & -1/3 & -2/3 \\ 2/3 & 2/3 & 1/3 \end{bmatrix}$ is orthogonal and also its Eigen values have unit magnitude.

19. A covariant tensor has components $x + y,\ x\,y,\ 2z - y^2$ in rectangular co-ordinate system. Find its components in cylindrical co-ordinate system.

20. Solve three dimensional wave equation by separation of variable technique.

21. Express gamma function as an infinite product. Show that $\Gamma(z)\,\Gamma(1-z) = \frac{\pi}{\sin z\,\pi}$.

22. State and prove convolution theorem for Fourier transform. Find Fourier transform of a Gaussian function e^{-at^2} with $a > 0$.

(4 × 3 = 12 weightage)

D 12303 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY 1C 04—ELECTRONICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*
Each question carries 2 *marks.*

1. What are hybrid parameters ?
2. Give the difference between MOSFET and CMOS.
3. Differentiate BJT and FET.
4. Give the principle of tunnel diode.
5. Explain how a photodiode works.
6. Give the concept of virtual ground in operational amplifiers.
7. Differentiate open loop and closed loop gain associated with OPAMP.
8. What is Schmitt trigger ? Give the circuit diagram.
9. Explain the working of a voltage comparator using OPAMP.
10. Give the advantages of active filters over passive filters.
11. Differentiate RS and JK flip-flops.
12. Explain briefly, the basic components of a microprocessor.

(12 × 2 = 24 marks)

Section B

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. Explain the concept of power amplifier. Draw the circuit of a class A power amplifier and explain how it works ? Determine the voltage gain, output power and efficiency.

Turn over

14. Explain how a solar cell differs from a photodiode. Sketch the typical solar cell characteristics, and discuss the best operating point on the characteristics. Give some applications of solar cell.

15. What are OPAMP parameters ? Discuss various OPAMP parameters in detail.

16. What are shift registers ? Discuss the SISO, SIPO and PIPO registers in detail with the help block diagrams. Mention some applications of registers.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 7 marks.

17. Analyse the potential divider method of biasing an FET and write down the expressions for I_D, V_{GS} and V_{DS}.

18. What is meant by negative feedback ? With negative feedback, an amplifier gives an output of 10 V with an input of 0.5 V. When feedback is removed, it requires 0.25 V for the same output. Calculate a) gain without feedback, b) gain with feedback, and c) feedback fraction.

19. Draw the schematic diagram of a saw tooth wave generator. Also draw its input and output wave forms.

20. What is a differential amplifier ? The input voltages of an OPAMP are V_{i1} = 15 mV and V_{i2} = 140 mV. If the amplifier has a differential gain of A_d = 4000 and CMRR = 100. Calculate the output voltage of the amplifier.

21. What is a band pass filter ? A band pass filter has a lower and upper cut off frequencies of 300 Hz and 3000 Hz. Find the band width and resonant frequency.

22. What is a DAC ? A 4-bit D/A converter produces an output voltage of 4.5 V for an input code of 1001. What will be the value of the output voltage for an input code of 0011 ?

(4 × 7 = 28 marks)

D 12302 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Part A

Answer **all** *twelve questions.*
Each question carries 2 *marks.*

1. Give the three Greens identities.
2. What are gauge transformation and gauge fixing ?
3. Give magneto static boundary conditions.
4. What are Stokes parameters ?
5. What is anomalous skin effect ?
6. What are resonant cavities ?
7. What is Q of a cavity ?
8. What are Lienard- Wiechert potentials ?
9. Give Larmor formula for radiated power and explain the terms.
10. What are magneto sonic waves ?
11. Write Boltzmann equation and explain.
12. Write the Lorentz transformation matrix and explain.

(12 × 2 = 24 marks)

Part B

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. Derive the first and second equation of magneto statics $\nabla.\vec{B} = 0$ and $\nabla \times \vec{B} = \mu_0 \vec{J}$.
14. Obtain Kramer's-Kronig relations
15. Obtain expressions for fields and power of localized oscillating source
16. Obtain expressions for Lorentz transformed electric and magnetic fields

(2 × 14 = 28 marks)

Turn over

Part C

Answer any **four** *questions.*
Each question carries 7 marks.

17. A point charge q is brought to a position a distance d away from an infinite plane conductor held at zero potential. Using the method of images, find the work necessary to remove the charge q from its position to infinity.

18. Two long, cylindrical conductors of radii a_1 and a_2 are parallel and separated by a distance d, which is large compared with either radius. Show that the capacitance per unit length is given approximately by $C = \frac{\pi \in_0}{\ln(d/a)}$ where a is the geometrical mean of the two radii.

19. Consider a y-polarised electromagnetic wave incident normally at the interface of two lossless dielectrics with refractive indices n_1 and n_2. Write expressions for reflection and transmission co-efficients and find them if $n_1 = 1$ and $n_2 = 1.5$.

20. A charge q is uniformly distributed over a solid cylinder of radius R and length L. If this cylinder is rotated with a constant angular velocity w about its axis, What is volume current density $J(s,\phi,z)$ within the cylinder.

21. Obtain expressions for the phase and group velocities and show that for any mode $v_g v_p = \frac{c^2}{n^2}$ where c is the velocity of light and n is the refractive index.

22. A spherical conductor of radius R is immersed in a plasma and charged to a potential ϕ_0. The electrons remain Maxwellian and move to form a Debye shield, but the ions are stationary during the time frame of the experiment. Assuming $e\phi_0 << kT$ derive an expression for the potential as a function of r ?

(4 × 7 = 28 marks)

D 12301 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY1 C 02—MATHEMATICAL PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*
Each carry 2 marks.

1. State the quotient rule for tensors.
2. Prove that the momentum operator is Hermition.
3. What is meant by Wronskian, explain how Wronskian is used for finding the properties of solution of a differential equation.
4. Show that the eigen vectors corresponding to different eigen values of Hermition operators are orthogonal.
5. Explain the similarity transformation.
6. Show that every square matrix can be uniquely expressed as the sum of Hermition and skew Hermition matrix.
7. Obtain the parity relation for the associated Legendre polynomial function.
8. Explain the singular point of a differential equation with an example.
9. Write the Rodriguez formula for the Laguerre polynomial. Find $L_0(x)$ and $L_1(x)$.
10. What is Fourier series, Explain the convolution theorem.
11. What is Laplace transform, Explain its linearity property.
12. Check whether the differential equation $(1-x^2)y'' - 3xy' + n(n+1)y = 0$ is self adjoint or not.

(12 × 2 = 24 marks)

Turn over

Section B

Answer any **two** *questions.*
Each carry 14 *marks.*

13. Obtain the solution for Laplace equation in spherical polar co-ordinate system using variable seper-able method.

14. What is diagonalization of a matrix. Diagonalize the matrix $A = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$.

15. Obtain the generating function of Besssel polynomial, and using it obtain any four recurrence relations for Bessel function.

16. What are Fourier integral transforms, discuss its main properties. Show that Fourier transform of a Gaussian function is also Gaussian.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each carry 7 *marks.*

17. Find the eigen values and eigen vectors of a matrix $A = \begin{pmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{pmatrix}$.

18. Find the Laplace transform for the function $F(t) = \sin \omega t\ ; 0 < t < \frac{\pi}{\omega}, F(t) = 0\ ; \frac{\pi}{\omega} < t < \frac{2\pi}{\omega}$ with period $T = \frac{2\pi}{\omega}$.

19. A covarient tensor has the components xy, $2y - z^2$, xz in cartesian system, Find its covarient components in spherical polar co-ordinate system.

20. Show that $J_{n(x)} = \frac{1}{\pi}\int_0^{\pi} \cos\left(n\theta - x\sin\theta\right) d\theta$.

21. Obtain the orthogonality condition for Legendre polynomial.

22. Show that displacement vector and velocity transforms like a contravarient vector where as gradient of a scalar function transforms like a covarient vector.

(4 × 7 = 28 marks)

D 12300 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY 1C 01—CLASSICAL MECHANICS AND CHAOS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*
Each question carries 2 *marks.*

1. Write down the expression for Lagrangian of a free particle in spherical polar co-ordinate system.
2. Show that if a co-ordinate is cyclic in Lagrangian, it is cyclic in Hamiltonian also.
3. What are the advantages of Lagrangian formulation over Newtonian formulation ?
4. What is Hamilton's principal function ? What is its significance ?
5. Write a note on action - angle variables.
6. Show that the Hamiltonian of a conservative system represents the total energy of the system.
7. Define Poisson bracket. Expression the equation of motion of a function F in terms of Poisson bracket.
8. What is an infinitesimal rotation ? What is its importance ?
9. Why Hamiltonian is known as the generator of system motion ?
10. Define normal modes and normal co-ordinates of a system executing small oscillations
11. What is chaos ?
12. What is a logistic map ?

(12 × 2 = 24 marks)

Section B

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. State the inverse square law of force. Discuss the Kepler problem in detail and arrive at the equation of orbit. Classify the orbits according the value of energy of the system.

Turn over

14. (a) Show that the Hamiltonian is a Legendre transform of Lagrangian and obtain Hamilton's canonical equations.

    (b) Obtain the equation of motion of a linear harmonic oscillator by Hamilton's method.

15. Derive Euler equations of motion. Solve the Euler equations for the torque free rotation of a rigid body.

16. What are forced vibrations. Discuss the effect of dissipative force on the forced vibrations hence show that the forced oscillations exhibit resonance behavior in the neighborhood of frequencies of free oscillations.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 7 marks.

17. A particle of mass m moves on the xy-plane under the action of a force field given by $\mathrm{F} = -(kr\cos 0)\hat{r}$, where k is a constant and r is the radial vector. Show that the angular momentum of the particle is conserved. Also obtain the equation of motion.

18. Obtain the Hamiltonian and equations of motion of a particle moving near the surface of earth.

19. Show that the Schrödinger equation is the quantum mechanical form of Hamilton-Jacobi equation.

20. Using Poisson bracket, obtain the values of α and β such that the transformation given by $\mathrm{Q} = q^{\alpha}\cos\beta\mathrm{P}$ and $\mathrm{P} = q^{\alpha}\sin\beta\mathrm{P}$.

21. Show that for the torque free rotation of a rigid body, the rotational kinetic energy and the angular momentum are conserved.

22. Determine the normal frequencies of two coupled oscillators whose Lagrangian is given by $\mathrm{L} = \frac{1}{2}m\left(\dot{x}_1^2 + \dot{x}_2^2\right) - \frac{1}{2}m\omega_0^2\left(x_1^2 + x_2^2\right) + m\omega_0^2\mu x_1 x_2$, where m is the mass of the oscillators.

(4 × 7 = 28 marks)