D 93610 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(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 is biasing in transistors ? Give various methods of FET biasing.
2. Give the difference between MOSFET and CMOS.
3. Differentiate tunnel diode and LED.
4. What is LDR ? Give any *two* applications of LDR.
5. Define CMRR and slew rate of an OP-AMP.
6. What is a differential amplifier ? Why it is called so ?
7. List 4 characteristics of an ideal OP AMP.
8. What is zero crossing detector ? Give the circuit diagram.
9. Differentiate saw tooth and triangular wave forms.
10. Differentiate active and passive filters.
11. Give the advantage of using JK MS flip-flop over JK flip-flop.
12. Differentiate synchronous and asynchronous counters.

(12 × 2 = 24 marks)

Turn over

Section B

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

13. Explain the construction and working of an FET. Define FET parameters and establish the relationship between them.

14. Sketch the cross section of a typical photodiode and explain its operaton. Sketch typical photodiode characteristics and discuss their shape.

15. Discuss the theory and working of an OP-AMP integrator with the help of a circuit diagram and wave forms. Obtain the expression for the output voltage in terms of the input voltage.

16. Draw the functional block diagram of an 8085 microprocessor and explain each block separately in detail.

(2 × 14 = 28 marks)

Section C

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

17. Give the advantages of FET over BJT. For an N channel FET, I_{DSS} = 8.7 mA, V_p = – 3 V, V_{GS} = – 1 V. Find the values of I_D, g_{mo} and g_m.

18. What are the advantages of negative feedback ? An amplifier has an open loop gain of 400 and a feedback factor of 0.2. Find the percentage change in closed loop gain if the open loop gain changes by 25 %.

19. For OP-AMP-741, the following parameters are given. Quiescent collector current I_c = 9.5 μA, C_c = 30 pF, peak amplitude of input voltage V_m = 15 V. Calculate the slew rate and full power band width (f_{max}).

20. What is a summing amplifier ? Sketch the circuit of a summing amplifier using OP-AMP to get an output voltage $V_o = 1V_1 + 2V_2 - 3V_3$.

21. With the help of diagram and truth table explain the working of JK Master Slave flip-flop.

22. What is DAC ? A D/A converter has a full scale analog output of 10 V and accepts 6 binary bits as inputs. Find the voltage corresponding to each analog step.

(4 × 7 = 28 marks)

15. Explain energy flow and attenuation in wave guides.

16. Obtain the Larmor formula for the power radiated by a point charge

(2 × 14 = 28 marks)

Part C

Answer any **four** *questions each carries* 7 *marks.*
Each question carries 14 *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 force between the plane and the charge by using Coulomb's law for the force between the charge and its image

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 $C = \frac{\pi \in_0}{\ln(d/\alpha)}$ where a is the geometrical mean of the two radii.

19. A long copper rod of radius R carries a uniformly distributed free current I. Find H inside and outside the rod.

20. A long coaxial cable carries current I. Find the magnetic energy stored in a section of length I. Inner radius is 'a' and outer radius is 'b'

21. An infinite straight wire carries the current.

    $I(t) = 0 ; t < 0$

    $I(t) = I_0 ; t > 0.$

    Find the resulting electric and magnetic fields.

22. Give a simple form of the kinetic equation expressing the collision integral through a typical time of change of a particle trajectory.

(4 × 7 = 28 marks)

D 93608 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

Physics

PHY 1C 02—MATHEMATICAL PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. Evaluate $\nabla . \vec{r}$, for $r \neq 0$ where r is a function of (x, y, z).
2. What do you mean by pseudo vector and pseudo scalar. Give examples.
3. Write the transformation relations for a second rank contra variant, covariant and mixed tensors.
4. Show that δ^i_j is mixed rank tensor of rank 2.
5. If A is orthogonal, show that its determinant = ±1.
6. Show that every square matrix can be uniquely expressed as the sum of Hermition and skew Hermition matrix.
7. Define Gamma function, find its recursion relation.
8. Write the form of a Sturm - Liouville differential operator, mention its two important properties.
9. What is meant by essential and non-essential singularity of a differential equation ?
10. Write the Fourier transform equations for position and momentum space.
11. What is Laplace transform ? Give some examples.
12. What is Dirac delta function ? Mention two application of this function in physics.

(12 × 2 = 24 marks)

Section B

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

13. Obtain the expressions for gradient, divergence and curl in cylindrical co-ordinate system.
14. What is diagonalization of a matrix ? Diagonalize the rotation matrix.

Turn over

15. Find the solution of Legender differential equation using Frobenius method.

16. Demonstrate Gram-Schmidt orthogonalization using an example.

(2 × 14 = 28 marks)

Section C

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

17. Find the eigen values and eigen vectors of the matrix $A = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$.

18. Solve Laplace's equation, $\nabla^2\psi = 0$, in cylindrical polar co-ordinates for $\psi = \psi(r)$.

19. Find the value of the integral $\int_0^\infty \sqrt{x}e^{-\sqrt[6]{x}}\,dx$.

20. Show that $\Gamma(m+n) = \frac{\Gamma m \Gamma n}{\beta(m,n)}$.

21. Obtain the Rodriguez formula for Hermite polynomial.

22. Represent the function $f(x) = x$ with $-\pi < x < \pi$ in the form of a Fourier series.

(4 × 7 = 28 marks)

D 93607 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(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. Define "generalized coordinates". What is the advantage of using generalized coordinates ?
2. Write down the Rayleigh dissipative function. What is its significance ?
3. Write the expression for Laplace-Runge-Lenz vector. Show that its dot product with the angular momentum vanishes.
4. Illustrate the concept of phase space.
5. What is identity transformation ? Show that $F = q_j P_j$ generates identity transformations.
6. What is Hamilton's characteristic function ? What is its significance ?
7. What is the advantage of using action - angle variables ?
8. What are Euler angles ? What is its significance ?
9. Explain the effect of Corioli's force on body projected with a velocity v in the northern hemisphere of earth.
10. What are the two factors that determines the excitation of normal modes of oscillation ?
11. What are limit cycles ?
12. What are linear and nonlinear oscillations ?

(12 × 2 = 24 marks)

Section B

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

13. State and prove D' Alembert's principle. Obtain the Lagrange's equation of motion from D' Alembert's principle for a holonomic conservative system.
14. What do you mean by a canonical transformation ? Solve the linear harmonic oscillator problem by the method of canonical transformation. Sketch the phase portrait of a linear harmonic oscillator.

Turn over

15. State and explain the Euler theorem on the motion of a rigid body. Show that the orthogonal matrix specifying the motion of a rigid body, one point of which is fixed, always has an eigen value +1 .

16. (a) Write a brief note on stable and unstable equilibrium. Draw the potential energy curve of each.

    (b) Show that the eigen value equation of small oscillations can be expressed in the form $A\eta = \omega^2\eta$ where $A = T^{-1}\vec{V}$ and ω is the eigen frequency.

(2 × 14 = 28 marks)

Section C

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

17. If L is the Lagrangian of a system of n degrees of freedom, satisfying Lagrange's equation of motion ; show that $L' = L + \frac{dF}{dt}$ also satisfies the Lagrange's equation of motion, where $F \equiv F(q_1, q_2, \ldots q_n, t)$ is an arbitrary differentiable function of its arguments.

18. Obtain the expression for the acceleration of masses in an Atwood's machine by using Hamilton's method.

19. A canonical transformation is given by, $Q = ln\left(\sin\frac{p}{q}\right)$ and $P = q\cot p$. Find the Poisson bracket $[Q,P]_{q,p}$. Also show that $[H,[Q,P]] = 0$.

20. The Hamilton's characteristic function of a particle is given by the following expression : $W = \int\sqrt{(2m\alpha_x - mkx^2)}dx + \int\sqrt{(2m\alpha_y - mky^2)}dy + \int\sqrt{(2m\alpha_z - mkz^2)}dz$. Obtain the components of canonical momenta and the corresponding action variables.

21. Find the normal frequencies and normal coordinated of the system whose Lagrangian is given by,

$$L = \frac{1}{2}(\dot{x}^2 + \dot{y}^2) - \frac{1}{2}(\omega_1^2 x^2 + \omega_2^2 y^2) + axy.$$

22. A particle of mass m is thrown vertically upwards with a velocity u in the northern hemisphere at a latitude α. Determine the deviation of the particle from the vertical when it returns. The variation in the gravity may be neglected.

(4 × 7 = 28 marks)

D 93606 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

Physics

PHY 1C 04—ELECTRONICS

(2017 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. Give any two advantages of FET over BJT.
2. Briefly explain emitter follower with a circuit diagram.
3. Give the principle of photo diode.
4. Define short circuit current and fill factor associated with solar cell.
5. Draw the V-I characteristics of a tunnel diode.
6. Give the Op-amp block diagram representation.
7. List the characteristics of ideal Op amp.
8. Draw the frequency response curves of band pass and band reject filters.
9. Differentiate comparator and Schmitt trigger.
10. Differentiate saw tooth wave and triangular wave.
11. What are shift registers ? Give one application.
12. Differentiate synchronous and asynchronous counters.

Total Marks $12 \times 2 = 24$

Section B

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

13. Draw the basic differential amplifier circuit using transistors and explain. Derive expression for the ac voltage gain in the single ended and double ended configuration.
14. Discuss the analysis of common drain amplifier at low frequencies.

Turn over

15. What are filters ? Briefly explain how they are classified. With the help of a circuit diagram and frequency response curve derive an expression for the voltage gain of a first order high-pass Butter worth filter.

16. Distinguish between combinational logic and sequential logic circuits. Draw the circuit diagram of a master slave JK flip-flop and explain its working using truth table. How is it different from edge triggering ?

Total Marks 2 × 14 = 28

Section C

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

17. Sketch the input and output wave forms of a non inverting comparator with positive and negative reference voltage.

18. With a circuit diagram, discuss the small signal model of an FET at low frequencies.

19. Draw the block diagram of a voltage series feedback amplifier. Obtain its closed loop voltage gain.

20. Discuss semiconducting laser operation with an energy level diagram.

21. Design a differentiator that will differentiate an input signal of f_{max} = 100 Hz.

22. Define power amplifier. A power amplifier supplies 50 W to an 8 Ω speaker. Find ac output voltage and ac output current.

Total Marks 4 × 7 = 28

D 93605 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

Physics

PHY. IC 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2017 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. Explain Laplace and Poissons equations.
2. What is multipole expansion ?
3. What is meant by gauge transformation. Explain.
4. What is polarisation of light ?
5. What are waveguides ?
6. Write Lorentz transformation equations and explain.
7. Write down the Maxwell's equations in the differential forms and give their significance.
8. Write down the inhomogeneous wave equation for scalar and vector potential and explain the terms.
9. Discuss the electromagnetic boundary conditions.
10. What is Larmor formula ?
11. What is Debye shielding ?
12. What are Alfven waves ?

(12 × 2 = 24 marks)

Section B

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

13. Obtain the solutions of non-homogeneous wave equations for potentials.
14. Discuss the behavior of electromagnetic waves in a non-conducting medium.

15. What are wave guides ? Discuss the behavior of TE waves in rectangular waveguides.

16. Obtain the 4 vector tensor form of electromagnetic field.

(2 × 14 = 28 marks)

Section C

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

17. Determine the electric field caused by a spherical cloud of electrons with a volume charge density $-\rho$ for $0 \leq r \leq b$. Charge density is zero for $r > b$.

18. Find the magnetic flux density at the center of a square loop with side w carrying a current I.

19. An a.c. voltage source $V_0 \sin wt$ of amplitude V_0 and angular frequency w are connected across a parallel plate capacitor with capacitance C. Show that the displacement current is the same as the conduction current.

20. Show that fresh water behaves as a good conductor for frequency 10 Hz and a poor conductor for frequency 10 GHz. Take relative permittivity as 80 and $\sigma = 10^{-3} \frac{\Omega}{m}$.

21. Establish the Lorentz invariance of $E^2 - C^2B^2$.

22. Show that Debye screening length

$$\lambda_D = \left(\frac{\epsilon_0 \, kT}{2n_0 e^2} \right)^{1/2}$$

where n_0 is the electron density at the local potential region.

(4 × 7 = 28 marks)

D 93435 (Pages : 3) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY IC 04—ELECTRONICS

(2019 Admissions)

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. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

Answer **all** *questions, each carries weightage* 1.

1. Briefly explain any *two* ideal parameters of an operational amplifier.
2. How can you change the colours of emission in a LED ? Give any *two* examples for different colours.
3. Briefly explain fill factor and efficiency.
4. Distinguish between BJT and FET.
5. Briefly explain the advantages of Karnaugh map in logic circuit design..
6. Describe the working of a PN junction diode as a solar cell.
7. Write a short note on switching action of a MOSFET.
8. How can you convert an SR Flip-flop to a D Flip-flop ?

(8 × 1 = 8 weightage)

Section B

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

9. With the help of a logic circuit briefly explain the working of a decade counter.
10. How can you construct an active high pass filter using operational amplifier ? Explain its working.

Turn over

11. What is the use of positive feedback ? With the help of a circuit explain the working of a Wien bridge oscillator.

12. With the help of a circuit explain the conversion of an analog signal to digital signal.

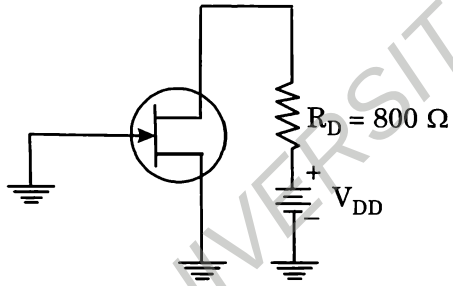
(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions, each question carries weightage* 3.

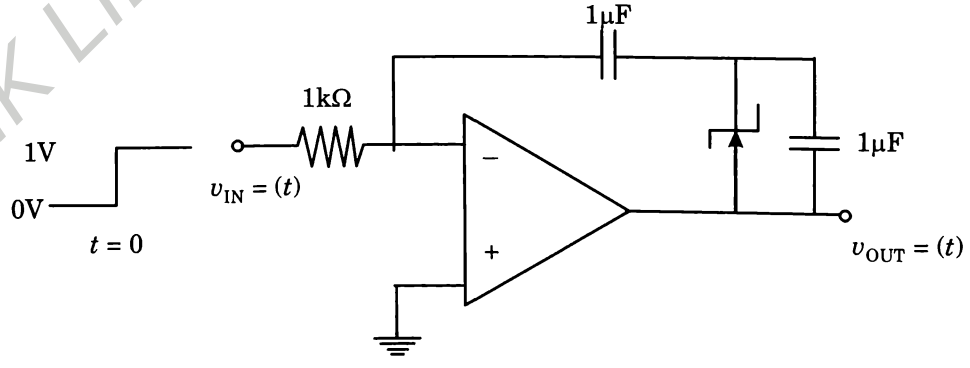
13. Design an Integrator that integrates signals with frequencies down to 200 Hz and produces a peak output of 0.5 V when the input used is a 25 V peak sine wave having frequency 20 kHz.

14. For the JFET in the given figure, $V_{GS\ (off)}$ is –4V and I_{DSS} is 10 mA. Determine the minimum value of V_{DD} required to put the device in constant current area of operation :



15. Design a first order Butterworth low pass filter circuit using operational amplifier with a cutoff frequency 15.9 kHz. C = 0.001 μ F and A_{max} = 1.5

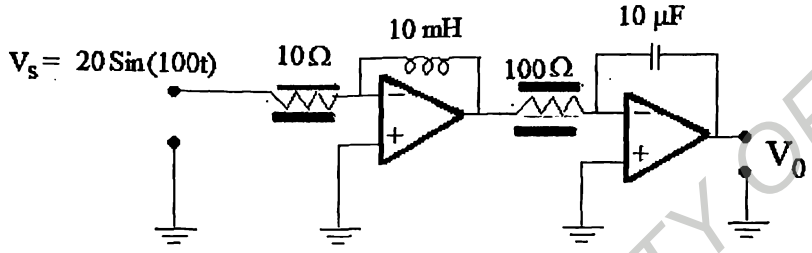
16. In the circuit shown below, the op-amp is ideal and Zener voltage of the diode is 2.5 volts. At the input, unit step voltage is applied, *i.e. vin* (*t*) = *u* (*t*) volts. Also, at *t* = 0, the voltage across each of the capacitors is zero. Find the time '*t*' in milliseconds, at which the output voltage V_{out} crosses the Zener break down.



17. Using Karnaugh Map solve the given equation to reduce the number of gates used :

$$Y = \bar{A}\bar{B}CD + \bar{A}BCD + ABCD + A\bar{B}CD + AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D}.$$

18. In the figure given below assume the ideal op-amp is used. Find the output voltage if an input signal $V_s = 20 \text{ Sin } (100t)$ is applied.



19. Design an astable multi-vibrator using operational amplifier to get 500 Hz.

(4 × 3 = 12 weightage)

D 93434 **(Pages : 2)** **Name**.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 30 Weightage

General Instructions.

Section A

Eight short questions answerable within 7½ minutes.
Answer **all** *questions.*
Each question carries weightage 1.

1. Explain the Lorentz gauge condition for potentials.
2. State and explain Poynting's theorem.
3. Explain Snell's law of refraction in the case of oblique incidence at a plane dielectric boundary.
4. What are evanescent waves ?
5. Write down the time-harmonic transmission-line equations for phasors V (z) and I (z).
6. The magnetic field is zero in the particle's rest frame S_0. What is the value of magnetic field in a system S, moving with a speed v relative to S_0 ?
7. Give the stress tensor for plasmas in the presence of magnetic field.
8. Outline the criteria for plasmas.

(8 × 1= 8 weightage)

Section B

Four essay questions answerable within 30 *minutes.*
Answer any **two** *questions.*
Each question carries weightage 5.

9. Derive the time harmonic Helmholtz's equations for scalar potential V and vector potential A. What are its solutions ?
10. Obtain the instantaneous field expressions for TE modes in a rectangular waveguide of sides a and b.
11. Express the field tensor in terms of four vector potentials. Also, deduce the Maxwell's equation in potential form.
12. Derive the fluid equations of motion from the moments of Boltzmann equation.

(2 × 5 = 10 weightage)

Turn over

Section C

Seven problems answerable within 15 minutes.
Answer any **four** *questions.*
Each question carries weightage 3.

13. Express $(4 \cos \omega t - 3 \sin \omega t)$ as first (a) $A_1 \cos(\omega t + \theta_1)$, and then (b) $A_2 \sin(\omega t + \theta_2)$. Determine $A_1, A_2, \theta_1, \theta_2$.

14. Derive the relation between group velocity and phase velocity. Also, detail the conditions of dispersion.

15. Assume that a uniform plane wave in a lossless medium with intrinsic impedance η is incident normally onto another medium with intrinsic impedance ξ, through a plane boundary. Evaluate the expression connecting reflection coefficient and transmission coefficient.

16. Find the size of a hollow cubic cavity made of copper in order to have a dominant resonant frequency of 9 GHz. Also evaluate the quality factor at that frequency. ($\sigma = 5.8 \times 10^7$ S/*m*).

17. Prove that the current density vector, J^{μ}, is divergenceless.

18. Compute λ_D and N_D in the earth's ionosphere with ion concentration $10^{13}/m^3$ and kT_e from 0. leV to 0.01 eV.

19. Derive an expression for plasma frequency in the absence of magnetic field and thermal motion.

$(4 \times 3 = 12$ weightage)

D 93433 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE [REGULAR/SUPPLEMENTARY] EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 1C 02—MATHEMATICAL PHYSICS—I

(2019 Admissions)

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. *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 question carries weightage* 1.

1. Obtain the expression for line element in spherical polar co-ordinates.
2. With an example explain Hermitian operators.
3. Explain concept of extension of rank by differentiation for a tensor.
4. With an example explain features of an elliptic partial differential equation. Laplace equation- its features.
5. Using Rodrigue's formula evaluate $\int_{-1}^{+1} P_0(x)\,dx$.
6. Explain Gram-Schmidt orthogonalization.
7. Explain the general form of a second order differential equation and classify them based on being elliptic, parabolic or hyperbolic.
8. Explain briefly any *two* uses of Fourier series.

(8 × 1 = 8 weightage)

Turn over

Section B

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

9. Explain the algebraic operations of Tensors.

10. Explain the origin of Spherical Bessel function. What is the required orthogonal property of spherical Bessel functions ?

11. Explain any *five* properties of Fourier series.

12. What are orthogonal curvilinear coordinate systems ? Obtain the mathematical expression for divergence in terms of curvilinear coordinates.

(2 × 5 = 10 weightage)

Section C

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

13. Expand the function $f(x) = x^2$ in the interval $-\pi < x < \pi$ and hence evaluate $\sum_{n=1}^{\infty} \frac{1}{(2n-1)^2}$.

14. Using Frobenius' method find solution of linear oscillator equation $\frac{d^2y}{dx^2} + \omega^2 y = 0$.

in powers of x i.e near $x = 0$.

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

16. A string of length π is stretched until the wave speed is 40 m/sec. It is given an initial velocity of 4 sin (x) from its initial position. When does the maximum displacement occur ?

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

18. For the Legendre polynomial prove that $P_n(x) = 1$.

19. If H is a Hermitian matrix prove that e^{iH} is unitary ?

(4 × 3 = 12 weightage)

D 93432 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY IC 01—CLASSICAL MECHANICS

(2019 Admissions)

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. *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. State the principle of least action.
2. Explain how action angle variables can be used to obtain the frequency of periodic motion.
3. What do you mean by precession and nutation ?
4. Briefly explain stable and unstable equilibrium.
5. Explain the concept of Universality.
6. Describe the fixed point using suitable example.
7. State and explain Hamilton's principle.
8. Give the relation between Lagrangian bracket and Poisson bracket.

(8 × 1 = 8 weightage)

Turn over

Section B

4 Short questions answerable within 30 minutes.
Answer any **two** *questions, Each carry weightage 5.*

9. Obtain Lagrange's equation from d'Alembert's principle. Give examples of generalized co-ordinates.
10. Discuss the general theory of small oscillations and deduce eigenvalue equation.
11. Show that Poisson brackets are invarients under canonical transformations. Also, express equation of motion in Poisson bracket form.
12. Differentiate between linear and non-linear systems. Explain the period doubling route to chaos with a suitable example

(2 × 5 = 10 weightage)

Section C

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

13. Masses m and $2m$ are connected by a light inextensible string which passes over a pulley of mass $2m$ and radius α. Write the Lagrangian and find the acceleration of the system.
14. Show that the shortest distance between two points is a straight line.
15. Obtain Hamilton's equations for a simple pendulum. Hence, obtain an expression for its period.
16. Find the Poisson bracket of $[Lx, Ly]$, where Lx and Ly are angular momentum components.
17. Find the moments and products of inertia of a homogeneous cube of side a for an origin at one corner, with axes directed along the edges.
18. Find the normal frequencies and normal modes for a double pendulum, each having a mass m suspended by a string of length l.
19. Show that the following transformation is canonical. $Q = \sqrt{2qe}^{\alpha} \cos p, P = \sqrt{2qe}^{-\alpha} \sin p$, α is constant.

(4 × 3 = 12 weightage)

D 93253 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY 1C 04—ELECTRONICS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*

Each question carries weightage 1.

1. Explain how FET differ from BJT.
2. What do you mean by ON drain resistance ?
3. Draw a schematic representation of a p-n junction solar cell and write down the equation for ideal I-V characteristics of the same.
4. Differentiate the construction of depletion-type and enhancement-type MOSFETs ?
5. Describe the operation of a FET as a negative NAND gate. Give the truth table and Boolean expression.
6. Draw the schematic block dia ram of a basic OPAMP with inverting and non inverting inputs.
7. Explain CMRR.
8. Define input bias current.
9. Differentiate JK and RS flip-flops.
10. Write any two data transfer in tractions and explain it.
11. Explain the function of ALU in 8085.
12. What is meant by population inversion ?

(12 × 1 = 12 weightage)

Section B

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

13. Briefly describe how the MOSFET working as NAND and NOR gates. Give the circuit, truth table and Boolean expressions.

14. Describe important parameter of operational amplifiers.

15. Illustrate the working of a Wein bridge oscillator with neat diagram.

16. Explain the internal architecture of 8085 microprocessor.

(2 × 6 = 12 weightage)

Section C

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

17. Give a brief description about Small-signal MOSFET circuit model.

18. A MOSFET has a drain-circuit resistance R_d of 100K and operates at 20 kHz. Calculate the voltage gain of this device as a single stage, and then as the first transistor in a cascaded amplifier consisting of two identical stages. The MOSFET parameters are g_m = 1.6mA/V, r_d = 44K, C_{gs} = 3.0pF, C_{ds} = 1.0pF, and C_{gd} = 2.8pF.

19. Describe the Characteristic equations of : (a) SR flip-flop, (b) D flip-flop, (c) JK flipflop, (d) T flip-flop.

20. Explain the first order low-pass filter using an op-amp and its frequency response.

21. Explain the wide and narrow and pass filters.

22. Describe the working of a op-amp diffrentiator with circuit diagram.

(4 × 3 = 12 weightage)

D 93252 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

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

1. Write the integral form of Maxwell's equations and identify their experimental laws.
2. Define Lorentz condition. What is its significance ?
3. Explain the concept of polarisation of electromagnetic waves. Distinguish between circular and elliptical polarisation.
4. Define reflection and transmission co-efficients. Under which conditions the reflection co-effient at parallel polarisation becomes equal to reflection co-efficient at perpendicular polarisation ?
5. What are the essential differences between a transmission line and an ordinary electric network ?
6. Distinguish between half wave and quarter wave transmission lines.
7. Discuss the wave guide characteristics affected by the linear dimensions a and b of the cross-section of a rectangular guide.
8. What is four vector ? Express current density in *four* vector form.
9. Explain invariants and covariance in relativistic electrodynamics.
10. Define plasma and plasma parameter.
11. Explain why plasma exhibits diamagnetic character ?
12. Define convective derivative of a function G (r, t) in three dimensions.

(12 × 1 = 12 weightage)

Turn over

Section B

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

13. What is Poynting vector ? Discuss Poynting theorem as a consequence of law of conservation of energy.

14. Discuss the characteristics of propagation of TEM waves along a parallel plate transmission line using Maxwell's equations and derive the expressions for inductance L (per meter), capacitance C (per meter), and characteristic impedance Z_0.

15. Define electromagnetic field tensor. Use it to represent Maxwell's equations in covariant form.

16. Explain Debye shielding. Derive an expression for Debye length. What is its significance ?

(2 × 6 = 12 weightage)

Section C

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

17. Express Lorentz force law in terms of vector and scalar potentials

18. Calculate the degree of polarisation for ordinary light reflected from glass of index of refraction 1.5 to at an angle of 45°.

19. For an air filled waveguide determine the cut-off frequencies for TM_{11}, TM_{12} and TM_{21} modes if its cross-section has dimensions a = 2.29 cm. and b = 1.02 cm.

20. Show that E.B is Lorentz invariant.

21. Derive an expression for plasma frequency of ionised medium.

22. Compute Larmor radius and cyclotron frequency for a 3.5 MeV He^{2+} particle in an 8 Tesla DT fusion reactor.

(4 × 3 = 12 weightage)

D 93251 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY IC 02—MATHEMATICAL PHYSICS—I

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions*

Each question carries 1 *weightage.*

1. Derive expression for curl in curvilinear coordinate system.
2. Evaluate $\nabla \times \nabla \varnothing$.
3. What are orthogonal matrices ? Mention their properties and give one example.
4. Explain unitary transformations.
5. Define quotient law of tensors. Illustrate with an example.
6. Explain contravarient tensor with a suitable example.
7. Explain the significance of Self adjoint differential equation.
8. Classify singularity of a differential equation.
9. Define a Gamma function as definite integral and also as infinite product.
10. Define generating function of Legendre differential equation. Evaluate p0 (x).
11. Explain the application of inverse Laplace Transform with a simple example.
12. State and explain convolution theorem for Fourier transform.

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*

Each question carries 6 *weightage.*

13. Derive expression for gradient in general curvilinear coordinate system. Hence deduce it for Laplacian operator.

14. Apply separation of variable technique to find solution of Helmholtz equation in spherical polar coordinate system.

15. Explain Frobenius' method to find solution of a second order differential equation and apply this to linear oscillator problem.

16. What are the properties of Laplace transform. Apply Laplace transform to find solution of damped harmonic oscillator with initial conditions,

    $X(0) = X_0$ and $X'(0) = 0$.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*

Each question carries 3 *weightage.*

17. Find unit vectors in cylindrical co ordinate system. Show that the cylindrical co ordinate system is orthogonal.

18. Two matrices U and H are related by

    $U = e^{iaH}$ where 'a' is real and H is Hermitian then show that U is unitary and vice versa.

19. Explain the term direct product of tensors. Illustrate the formation of a mixed tensor of rank 2 from a covariant vector of rank 1 and a contra variant vector of rank 1 by direct Product.

20. Obtain Rodirigues formula for Legendre polynomials and hence find $P_2(x)$ from it.

21. Write the definitions of Gamma function by Euler (Definite integral). Derive the recurrence relation $\Gamma(z+1) = z\,\Gamma(z)$.

22. Analyze a saw tooth wave in terms of Fourier components.

    $f(x) = x, \qquad -\pi < x < \pi.$

(4 × 3 = 12 weightage)

D 93250 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY IC 01—CLASSICAL MECHANICS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

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

1. Differentiate Holonomic and non Holonomic constraints with examples.
2. Explain Hamilton's principle.
3. Explain virtual displacement.
4. Show that $P = \frac{1}{2}\left(p^2 + q^2\right), Q = \tan^{-1}\frac{q}{p}$ is canonical.
5. Explain Δ-variation. How it differ from δ-variation ?
6. Write the relation between Lagrange and Poisson Brackets.
7. Explain coriolis force.
8. Differentiate body and space co-ordinate system.
9. Explain stable and unstable equilibrium of a system.
10. What are normal vibrations and normal co-ordinates ?
11. What is meant by limit cycle ?
12. What is meant by a strange attractor ?

(12 × 1 = 12 weightage)

Turn over

Section B

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

13. Discuss the scattering of α-particle under a central force field and hence obtain the expression for Rutherford scattering cross section

14. Discuss Hamilton-Jacobi theory and apply it to solve the problem of harmonic oscillator.

15. Define Euler's angle and obtain an expression for the complete transformation matrix

16. What are normal vibrations and normal co-ordinates ? Discuss the small oscillations of CO_2 molecule and obtain the frequencies of their normal modes ?

(2 × 6 = 12 weightage)

Section C

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

17. Derive the Lagrangian for a charged particle moving in an electromagnetic field.

18. Show that $\left[J_x, J_y\right] = \left[J_z\right]$ using Poisson bracket.

19. Show that transformation defined by $= \sqrt{2P}\sin Q$, $p = \sqrt{2P}\cos Q$ is canonical by using Poisson bracket

20. Find the kinetic energy of rotation of a rigid body with respect to principal axes in terms of Euler's angles

21. Two bodies of mass m and $2m$ are connected by a spring constant k. Find the frequency at normal mode.

22. Write a note on chaotic attractors.

(4 × 3 = 12 weightage)

C 63450 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, MARCH 2019

Physics

PHY 103—CLASSICAL MECHANICS

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **five** *questions.*
Each question carries 4 *marks.*

1. Deduce the conservation theorems of linear momentum, angular momentum and energy for the motion of a particle and explain the first integrals of motion.
2. Deduce the equation of motion in Poisson brackets form and explain the canonical invariance of Poisson bracket.
3. Explain stable, unstable and neutral equilibrium using potential energy function.
4. What is central force motion ? Why it is always a motion in a plane ?
5. Explain the physical significance of Hamilton's principle and characteristic functions.
6. Briefly explain normal co-ordinates of a system executing small oscillation.
7. Define Eulers angles and obtain an expression for complete transformation matrix.
8. Give elementary ideas of attractors, limit cycles and fractal dimensions.

(5 × 4 = 20 marks)

Section B

Answer **both** *questions.*
Each question carries 20 *marks.*

9. Define Hamiltonian of a system and obtain Hamilton's equations of motion using variational principle.

Or

Obtain the solution of a simple harmonic oscillator using action angle variable.

10. Explain normal modes of vibration. Discuss the longitudinal vibrations of CO_2 molecules.

Or

What is period doubling and explian the Feigenbaum diagram using a logistic equation ?

(2 × 20 = 40 marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

11. Show that the kinetic energy is a quadratic function of generalised velocity.

12. Lagrangian is given by L = T – $e\phi$ + e/cA.v. If A and ϕ are independent of time 't'. Obtain the Hamiltonian.

13. Suppose we have transformaiton equation Q = log sin p/q, $p = q\cot p$. Show that the transformation is canonical and obtain the generating function.

14. The motion of the particle of mass m is described by the Hamiltonian $H = p_1^2/2m + p_2^2/2m + mAq_1$ where A is constant. Obtain the solution of the equation of motion using Poisson brackets.

(2 × 10 = 20 marks)

C 63449 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, MARCH 2019

Physics

PHY 102—ELECTRODYNAMICS AND PLASMA PHYSICS

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **five** *questions.*
Each question carries 4 *marks.*

1. State and explain electromagnetic boundary conditions.
2. Explain the advantage of representing electrodynamics in tensor notation. Also show that antisymmetry of a tensor is preserved by Lorentz transformation.
3. State and explain electromagnetic potentials.
4. Discuss guage transformations. Distinguish between Coulomb gauge and Lawrence gauge.
5. Prove that E.B is invariant under Lorentz transformation.
6. What you mean by Alfven waves and Alfven velocity ? Write down the expression between dielectric constant and Alfven velocity.
7. Explain Debye shielding. Obtain an expression for Debye length.
8. Briefly explain plasma frequency and deduce an expression for it.

(5 × 4 = 20 marks)

Section B

Answer **both** *questions.*
Each question carries 20 *marks.*

9. (a) Express magnetism as a relativistic phenomenon. Also explain how the fields transform.

Or

(b) Discuss with necessary theory the behaviour of motion of charged particle in uniform electric and magnetic field.

10. (a) (i) What are Cavity resonators ?

(ii) Briefly explain the applications of Cavity Resonators.

(iii) Derive the universal formula for group velocity.

Or

(b) (i) Discuss the propagation of TE waves in a rectangular waveguide and derive the expression for the cut-off frequency.

(ii) Derive the expression for the total power radiated by a point charge.

(2 × 20 = 40 marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

11. Show how wave equation for the electric field in free space is given by

$$\nabla^2 \times \mathbf{E} = \mu_0 \varepsilon_0 \frac{\partial^2 \overline{\mathbf{E}}}{\partial t^2}.$$

12. A rectangular wave guide measures 3 × 4 cm. internally and has 9 GHz signal propagating in it. Calculate the propagation constant, cut-off frequency and the guide wavelength for TE_{11} mode.

13. An electromagnetic wave is propagating in the TE mode in a rectangular wave guide of width b and height a. The walls of the wave guide are conducting and the inside is vacuum.

(a) What is the cut-off frequency in this mode ?

(b) If the inside is filled with dielectric constant ε, how does the cut-off frequency changes if $a = b$ and $m = n$?

14. Derive an expression for the depth of penetration for an electromagnetic wave in a conducting medium. Evaluate the depth of penetration for a 1 MHz wave in copper of conductivity 5.8×10^7 mhos/m and the permeability is approximately that of free space.

(2 × 10 = 20 marks)

FIRST SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, MARCH 2019

Physics

PHY 101—MATHEMATICAL PHYSICS—I

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **five** *questions.*
Each question carries 4 *marks.*

1. Calculate the spherical polar co-ordinates scale factors : h_r, h_θ and h_φ.
2. Define orthogonal matrices. If A and B are two orthogonal matrices, show that AB is also orthogonal.
3. Show that the velocity of a fluid at any point is a contravariant vector of rank one.
4. Prove that the momentum operator is Hermitian.
5. State and prove the quotient rule of tensors.
6. Prove that $P_n(-x) = (-1)^n P_n(x)$.
7. Prove that $2J'_n(x) = J_{n-1}(x) - J_{n+1}(x)$.
8. State and prove the convolution theorem.

(5 × 4 = 20 marks)

Section B

Answer any **two** *questions.*
Each question carries 20 *marks.*

9. (a) (i) Obtain the expression for divergence of a vector in terms of orthogonal curvilinear co-ordinates. (14 marks)

(ii) Show that the three-dimensional Levi-Civita symbol is a pseudotensor. (6 marks)

Or

(b) (i) Diagonalize the matrix $\begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$. (8 marks)

(ii) Write down the Helmholtz equation in three-dimensions using cartesian co-ordinates and show how the general solution can be obtained using the method of separation of variables. (12 marks)

Turn over

10. (a) (i) What are essential and non-essential singular points ? Show that Legendre's equation has regular singularities at $x = \pm 1$ and ∞.

(6 marks)

(ii) Obtain the orthonormality condition of Bessel's function. (14 marks)

Or

(b) (i) Using Hermite polynomials, analyze the quantum mechanical simple harmonic oscillator. (10 marks)

(ii) Evaluate the coefficients of Fourier series. (10 marks)

[2 × 20 = 40 marks]

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

11. Find the power series solution of linear oscillator equation $y'' + \omega^2 y = 0$. Using Frobenius' method.

12. Obtain the Rodrigue's formula for Legendre polynomials.

13. (a) Show that $\int_{-1}^{+1} x P_n(x) P_{n-1}(x) dx = \frac{2n}{4n^2 - 1}$. (5 marks)

(b) Show that $J_{\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}} \sin x$. (5 marks)

14. (a) Find the Laplace transform of the function $f(t) = \sin(hat) \sin(at)$. (5 marks)

(b) Apply Fourier's theorem to analyse the output wave from a full wave rectifier when input wave is of the form $E = E_0 \sin \omega t$.

(5 marks)

[2 × 10 = 20 marks]

C 63474 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, APRIL 2019

Physics

PHY 104—ELECTRONICS

(2003 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **five** *questions.*
Each question carries 4 *marks.*

1. Briefly explain CMRR and slew rate of an operational amplifier.
2. How can you change the color of an LED ? Give any *two* examples for different colours.
3. Write the working of a tunnel diode.
4. Distinguish between BJT and JFET.
5. Explain with example the use of Karnaugh map in logic circuit design.
6. Write the different registers used in 8085 microprocessor.
7. Write short notes on static and dynamic random access memory.
8. With circuit diagram explain any two mathematical operations of an op amp.

(5 × 4 = 20 marks)

Section B

Answer **both** *questions.*
Each question carries 20 *marks.*

9. (a) With the help of a logic diagram and truth table explain the working of a JK Master Slave flip flop.

Or

(b) Using operational amplifier explain differentiation and integration of voltage functions.

10. (a) Explain the different biasing techniques used in FET and also explain the working of a Source follower.

Or

(b) With the help of logic circuits explain synchronous and asynchronous counters.

(2 × 20 = 40 marks)

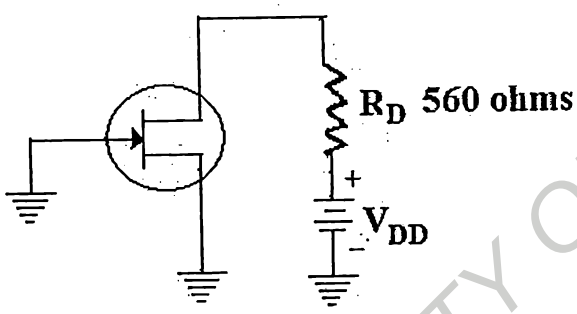
Turn over

Section C

Answer **all** *questions.*

Each question carries 5 *marks.*

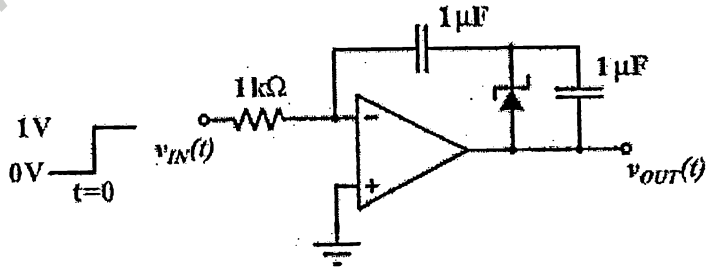
11. For the JFET in the given figure, $V_{GS\ (off)}$ is – 4 V and I_{DSS} is 12 mA, Determine the minimum value of V_{DD} required to put the device in constant current area of operation.



12. Show how an asynchronous counter can be implemented having a modulus of 7 with a straight binary sequence from 000 through 110.

13. Design a practical differentiator that will differentiate signals with frequencies up to 200 Hz. The gain at 10 Hz should be 0.1. If the op amp used in the design has a unity gain frequency of 1 MHz, what is the upper cutoff frequency of the differentiator ?

14. In the circuit shown below, the op-amp is ideal and Zener voltage of the diode is 2.5 volts. At the input, unit step voltage is applied, i.e. $v_{IN}(t) = u(t)$ volts. Also, at $t = 0$, the voltage across each of the capacitors is zero. Find the time t, in milliseconds, at which the output voltage V_{OUT} crosses the Zener break down.



(4 × 5 = 20 marks)

C 63473 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, APRIL 2019

Physics

PHY 103—CLASSICAL MECHANICS

(2003 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **five** *questions.*
Each question carries 4 *marks.*

1. Write a brief note on the relation between symmetries and conservation laws.
2. What do you mean by generalised coordinates ?
3. What are canonical transformations? Show that $q \to P, p \to -Q$ is an example for canonical transformation.
4. Write down the Hamiltonian and Hamilton's equations for a one dimensional simple harmonic oscillator.
5. Define Poisson bracket and write down the Poisson bracket relations for components of angular momentum
6. Show that Schrodinger equation goes over to the Hamilton-Jacobi equation in the classical limit.
7. Explain why centrifugal force is called a fictitious force.
8. What is meant by principal axis transformation in the context of small oscillations ?

(5 × 4 = 20 marks)

Section B

Answer **both** *questions.*
Each question carries 20 *marks.*

9. (a) (i) Derive Lagrange's equation from Hamilton's principle.

(ii) Derive Kepler's third law from Newton's equation asssuming circular orbits.

(10 + 10 = 20 marks)

Or

(b) (i) Discuss the concept of action-angle variables.

(ii) Write down the H J equation for one dimensional simple Harmonic Oscillator and solve them.

(10 + 10 = 20 marks)

Turn over

10. (a) (i) Discuss the concept of moment of inertia tensor.

(ii) Describe Eulers equations of a rigid body.

(10 + 10 = 20 marks)

Or

(b) (i) Derive the expressions for frequencies of normal oscillations of a linear triatomic molecule.

(ii) How does Coriolis force affect the formation of cyclones ?

(10 + 10 = 20 marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

11. Write down the Lagrangian for a simple pendulum restricted to a plane, obtain the equations of motion and get the formula for period assuming the displacement θ to be small.

12. Check whether the following transformations are canonical by calculating the Poisson brackets

(a) $Q = 2q, P = \frac{1}{2}p$ (b) $Q = q\cos\theta + p\sin\theta$ and $P = -q\sin\theta + p\cos\theta$.

13. Consider the matrix $R_z(\alpha) = \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$

Argue that this represents rotations with respect to the third axis and obtain the rotation matrix corresponding to infinitesimal rotations.

14. Consider an Atwood's machine type of arrangement in which two bodies of masses M_1 and M_2 are connected by a massless string passing over a friction less pulley. Obtain the equations of motion in this case.

(2 × 10 = 20 marks)

FIRST SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, APRIL 2019

Physics

PHY 101—MATHEMATICAL PHYSICS

(2003 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **five** *questions.*
Each question carries 4 *marks.*

1. What do you mean by trace of a matrix ? Show that it is invariant under similarity transformation.
2. Write down the expression for divergence and curl operator in cylindrical co-ordinates.
3. Find the direct product of the matrices $A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} a & 1 \\ 0 & b \end{bmatrix}$.
4. Show that $-i\frac{d}{dx}$ is a Hermitian operator.
5. Evaluate the following integral :

   $\int_0^\infty e^{-x^2}\left(x^3+1\right)dx.$
6. Use the properties of delta function to evaluate :

   $\int_{-\infty}^{+\infty} e^{-x^2}\sin(x)\,\delta(x-\pi)\,dx.$
7. Use Rodrigues's formula to get Legendre polynomials $P_1(x)$ and $P_2(x)$.
8. Define Laplace transform and get the transform for $\sin(wt)$.

(5 × 4 = 20 marks)

Section B

Answer **both** *questions.*
Each question carries 20 *marks.*

9. (a) (i) Define spherical polar and cylindrical co-ordinates and the transformation equations relating these to the Cartesian co-ordinate system.

(ii) What do you mean by diagonalisation of matrices ? The electrical conductivity of a crystal is given by the matrix :

$$\{\sigma_{ij}\} = \begin{bmatrix} 0 & 1 & 1 \\ 1 & \sqrt{2} & 0 \\ \sqrt{2} & 3 & 1 \end{bmatrix}.$$

Show that the conductivity along a particular direction in the crystal is zero.

(10 + 10 = 20 marks)

Or

(b) (i) Show that for a vector A,

$$\nabla \times (\nabla \times A) = \nabla(\nabla \cdot A) - \nabla^2 A.$$

(ii) Show that $\nabla \cdot (\nabla \times A) = 0$ and $\nabla \times (\nabla \phi) = 0$ where A is a vector and ϕ a scalar.

(10 +10 = 20 marks)

10. (a) (i) Explain Schmidt orthogonalisation procedure.

(ii) Describe Frobenius method.

(10 + 10 = 20 marks)

Or

(b) (i) For Hermite polynomials establish the recurrence relations :

$$H_{n+1}(x) = 2xH_n(x) - 2nH_n - 1(x).$$

(ii) Define and discuss properties of Dirac delta function.

(10 + 10 = 20 marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

11. Explain the idea of Schmidt orthogonalization procedure.

12. Find the inverse of the matrix $\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{bmatrix}$.

13. Find the Fourier transform of saw tooth function and step function.

14. Prove the recurrence relation : $xP_n(x) - P_{n-1}(x) nP_n(x)$.

(2 × 10 = 20 marks)