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1M1N24061 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

First Semester M.Sc Physics Degree Examination, November 2024

MPH1C01 – Classical Mechanics

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

PART A (Short answer questions)

Answer all questions. Each question carries a weight of 1 and answerable within 7.5 minutes

1. Write a note on Holonomic and Non-Holonomic constraints with example of each type.
2. Sate and explain Virial theorem.
3. Comment on the statement, 'Hamilton Jacobi equation is the shortest wavelength limit of Schrodinger equation'.
4. Explain stable, unstable and neutral equilibrium on the basis of potential energy functions.
5. Draw Feigenbaum diagram and obtain Feignbaum constants?
6. What is Coriolis force and Centrifugal force?
7. Obtain Hamilton's equation of motion from Hamilton's modified principle.
8. Write a short note on force free motion of a rigid body with reference to a symmetric top.

(8x1=8 weightage)

PART B (Essay Question)

Answer any two. Each question carries weight of 5 and is answerable within 30 minutes

9. Solve the problem of the linear harmonic oscillator using action-angle variables. Cite the circumstances where Hamilton Jacobi theory is more useful.
10. Derive the Kepler's three laws of planetary motion in the context of central force motion.
11. Discuss the free vibrations of a carbon dioxide molecule and obtain the normal modes and normal frequencies.
12. Derive the Euler's equation of motion for rigid bodies using Newtonian and Lagrangian method.

(2x5=10 weightage)

PART C (Problem questions)

Answer any four. Each question carries weight of 3 and is answerable within 15 minutes.

13. If F and G are functions of position co-ordinates q_i, and momentum co-ordinates p_i, define the Poisson's brackets of F and G.
    Prove that i) [F, G] = – [G, F] (ii) [qi , pj] = – δij
14. What is velocity dependent potential? Find the Hamiltonian of an electric charge q, of mass m moving at a velocity v, in an electromagnetic field.
15. Find the curve joining two points along which a particle falling from rest under the influence of gravity travels from the higher to the lower point in the least time.
16. A simple pendulum that is free to swing the entire solid angle is called a spherical pendulum. Find the differential equation of motion of a spherical pendulum using Lagrange's method. Also show that the angular momentum about a vertical axis though the point of support is a constant of motion.
17. Masses m and 2m are connected by a light inextensible string which passes over a pulley of mass 2m and radius a. Write the Lagrangian and find the acceleration of the system.
18. The Lagrangian of a system is given below. Find the eigen frequencies and eigen vectors of the system using the theory of small oscillation.

$$L = \frac{1}{2}m(\dot{x}_1^2 + \dot{x}_2^2) - \frac{1}{2}[(k + k_1)x_1^2 + (k + k_1)x_2^2] + k_1 x_1 x_2$$

19. Discuss the iteration of logistic equation $x_{n+1} = ax_n(1 - x_n)$,where $0 \leq x_n \leq 1$ *and* $1 \leq a \leq 4$, find the fixed point attractors and onset of chaos through period doubling.

(4x3=12 weightage)

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FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

First Semester M.Sc Physics Degree Examination, November 2024

MPH1C02 – Mathematical Physics

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

(Answer *all* questions. Each carries weightage of 1)

1. Give the significance of Dirac Delta Function
2. Explain quotient law for tensors.
3. Explain the general form of a second order differential equation and classify them based on being elliptic, parabolic or hyperbolic.
4. What are the advantages of curvilinear co-ordinate system ?
5. Explain the convolution property of Fourier transform with an example.
6. Wite a short note on the concept of outer product in tensors.
7. Explain when does a second-order linear homogeneous differential equation become self-adjoint.
8. Define generating function of Bessel differential equation. Evaluate $J_0(0)$.

(8x1=8 weightage)

Section B

(Answer *any two* questions. Each carries weightage of 5)

9. Explain the algebraic operations on Tensors.
10. Derive expression for Curl in general curvilinear co-ordinate system. Hence deduce it in spherical co-ordinate system.
11. Explain Gram-Schmidt orthogonalization procedure with a suitable example
12. Define a Fourier transform. Explain any five properties of Fourier transforms.

(2x5=10 weightage)

Section C

(Answer *any four* questions. Each carries weightage of 3)

13. Evaluate $\Gamma(\frac{1}{2})$

14. If H is a Hermitian operator, prove that e^{iH} is unitary.

15. Find Laplace transform of the function $F(t) = \frac{e^{at}-1}{a}$

16. Find the Fourier series of the function e^x in the interval $-\pi < x < \pi$

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

18. Using Frobenius' method to find the solution of linear oscillator equation

    $\frac{d^2y}{dx^2}+\omega^2 y=0$, near x=0

19. Check whether the given matrix is orthogonal, $A=\frac{1}{3}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ -2 & 2 & -1 \end{bmatrix}$

(4x3=12 weightage)

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FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

First Semester M.Sc Physics Degree Examination, November 2024

MPH1C03 – Electrodynamics & Plasma Physics

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

Answer all questions, each question carry weightage 1.

1. Write the expressions for retarded potentials. Also get the corresponding phasor quantities.
2. What is the Brewsters angle for the case of parallel polarization?
3. Show that current density four vector is divergence less?
4. What is the skin depth of a good conductor?
5. Explain why waves along a lossy transmission line cannot be purely TEM
6. Write down the electrodynamic boundary conditions.
7. What are the three types of guiding structures that support TEM waves?
8. Why plasma exist only at high temperature?

(8 x 1=8 weightage)

Section B

Answer any twoquestions, each carry weightage 5

9. Express all Maxwell equations and Lorentz force equation in tensor notation.
10. Discuss the reflection and transmission of EM waves at normal incidence at a plane dielectric boundary. Get a relation connecting reflection coefficient and transmission coefficient.
11. What do you mean by plasma? What are plasma oscillations? Get an expression for plasma frequency.
12. Explain the propagation of TM modes in a rectangular waveguide.

(2 x 5=10 weightage)

Section C
Answer any Four questions, each carry weightage 3

13. A sinusoidal electric intensity of amplitude250 V/m and frequency 2.45 GHz exist in a lossy dielectric medium that has relative permittivity of 40 and a loss tangent of 0.35. Find the average power dissipated in the unit volume.
14. Show that the orthogonality of E and B is preserved by Lorentz transformation.
15. Get the multipole expansion of V in powers of 1/r
16. (a)If the no. density of 5eV plasma is 10^{20} m^{-3}. (a) Find Debye length and N_D
    (b)Compute the Cyclotron frequency and Larmor radius for a electron travelling with a speed 500 m/s in a magnetic field of strength of 0.05 T
17. Show that in a good conductor, magnetic field intensity lags behind the electric field intensity by 45 degrees.
18. What is meant by a distortionless line? What relations must the distributed parameters of a line satisfy in order for the line to be distortionless?
19. What is Debye shielding? Get an expression for Debye length?

(4 x 3= 12 weightage)

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FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

First Semester M.Sc Physics Degree Examination, November 2024

MPH1C04 – Electronics

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A
(Answer all questions, each carry weightage 1)

1. What is the pinch-off voltage in a JFET?
2. Define threshold current density in a semiconductor laser.
3. Define the fill factor of a solar cell.
4. Define open-loop gain in an operational amplifier (op-amp).
5. What is CMRR, and why is it significant in op-amps?
6. Describe the characteristics of a Butterworth low-pass filter.
7. What is a shift register?
8. What is the SRAM?

(1x8 =8 weightage)

Section B
(Answer ANY TWO questions, each carry weightage 5)

9. Explain the construction and operation of depletion-mode and enhancement-mode MOSFETs.
10. Explain the construction and characteristics of a tunnel diode and describe its negative differential resistance and operation.
11. Explain the operation and characteristics of a differential amplifier, with emphasis on emitter-coupled differential amplifiers.
12. Describe the design and frequency response of active low-pass, high-pass, and band-pass Butterworth filters using OPAMPs.

(2x5 =10 weightage)

Section C
(Answer ANY FOUR questions, each carry weightage 3)

13. Design a differentiator to differentiate an output signal that varies in frequency from 10 Hz to about 1KHz
14. With the help of timing diagram and truth table explain the working of JK Master Slave flip-flop.
15. Design a low-pass filter at a cutoff frequency of 1 kHz with a passband gain of 2.
16. For an n-channel silicon FET with a $3x10^{-4}$ cm and $N_D = 10^{15}$ electrons/cm^3, find (a) the pinch-off voltage and (b) the channel half-width for $V_{GS} = ½ V_P$ and $I_D = 0$.
17. Given $g_{fs} = 2.8mS$ and $g_{os} = 10\mu S$, sketch the FET ac equivalent model.
18. If (i) $V_1 = 30\mu V$ and $V_2 = -30\mu V$ and (ii) $V_1 = 1000\mu V$, $V_2 = 900\mu V$ and common mode rejection ratio 100, calculate the percentage difference in output voltage obtained for the two sets of input signals.
19. In the astable multivibrator, $R_A = 2.2\ k\Omega$, $R_B = 3.9\ k\Omega$ and $C=0.1\mu F$. Determine the positive pulse width t_c and negative pulse width t_d.

(4x3 = 12 weightage)