PH 571.1

Reg. No. | | | | | | |

St Aloysius College (Autonomous)

Mangaluru

Semester I – P.G. Examination – M.Sc. Physics

February 2021

MATHEMATICAL PHYSICS - I

Time: 3 hrs. **Max Marks: 70**

PART - A

Answer all questions choosing ONE from each unit. **(15x4=60)**

UNIT- I

1. a) Explain concept of Volume integral. If $\vec{F}=(5xy-x^2)\hat{i}+(2y-4x)\hat{j}$, find the integral of $\vec{F}.d\vec{r}$ along the curve by $y=x^3$ in $x-y$ plane from point (1, 1) to (2, 8). **(8)**

b) State Stoke's theorem. Verify Stoke's theorem for $\vec{A}=(2x-y)\hat{i}-yz^2\hat{j}$, for the square surface of unit side. **(7)**

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OR

2. a) Express $\vec{\nabla}\phi$ and $\vec{\nabla}.\vec{E}$ in cylindrical coordinate system. **(8)**

b) Obtain and expression for the curl of a vector functions in curvilinear coordinates. Hence, identify it explicitly in spherical coordinate system. **(7)**

UNIT- II

3. a) Find the eigen value and eigen vector of the matrix $\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}$ **(5)**

b) Explain with examples the transformation properties of contravariant and covariant tensors. **(5)**

c) State and prove quotient law. **(5)**

OR

4. a) Define eigen values and show that the eigen values of Hermitian matrix are real and vectors corresponding to distinct eigen values are perpendicular to each other. **(10)**

b) Write a note on algebra of tensors. **(5)**

UNIT- III

5. a) Give an account of classification of second order partial differential equations into elliptic, parabolic and hyperbolic types. Provide an example for each type. **(9)**

b) Obtain the general solution of the equation $\frac{\partial^2\phi(x,y)}{\partial x^2}+\frac{\partial^2\phi(x,y)}{\partial y^2}=0$ in Cartesian coordinate system. **(6)**

Contd...2

OR

6. a) Separate the equation into three ordinary differential equations in cylindrical coordinates. **(10)**

b) Solve the partial differential equation $\frac{\partial^2 U(x,t)}{\partial x \partial t} = 6xe^{-t}$ by direct integration. **(5)**

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UNIT- IV

7. a) Obtain the orthogonality relation satisfied by Bessel functions. **(10)**

b) Show that Legendre polynomials satisfy the recurrence relation **(5)**
$(2n+1)xP_n(x) = (n+1)P_{n+1}(x) + nP_{n-1}(x)$

OR

8. a) Arrive at the series solution of Legendre differential equation. **(10)**

b) Show that Hermite Polynomial $H_n(x)$ satisfies the recurrence relation. **(5)**
$2xH_n(x) - 2nH_{n-1}(x) = H_{n+1}(x)$

PART – B **(5x2=10)**

Answer any <u>TWO</u> questions:

9. a) Find the gradient of a scalar function $\phi(r,\theta,\Phi) = r^3 \sin^2\theta \cos\theta \cos\phi \sin\phi$ in terms of spherical polar coordinates.

b) Show that $\sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$ is both Hermitian and Unitary.

c) Show that the gradient of a scalar field is covariant vector.

d) Show that the Hermite polynomials satisfy the relation
$\int_{-\infty}^{\infty} e^{-x^2} H_m(x) H_n(x) dx = 0$ if $m \neq n$.

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PH 572.1 Reg. No. | | | | | | |

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Semester I – P.G. Examination – M.Sc. Physics

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CLASSICAL MECHANICS

Time: 3 hrs. Max Marks: 70

PART - A

Answer all questions choosing ONE from each unit. (15x4=60)

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UNIT- I

1. a) Derive Lagrange's equations of motion from D'Alembert's principle. (10)

   b) What are constraints? Discuss their classification with an example. (5)

OR

2. a) State and prove work-energy theorem in the case of a single particle system. (5)

   b) Show that if the Lagrangian function does not contain the time explicitly the total energy for the conservative system is conserved. (10)

UNIT- II

3. a) Obtain the Hamiltanian and Hamilton's equation for a projectile. (5)

   b) Define canonical transformation and obtain the transformation equation corresponding to all possible generating functions. (10)

OR

4. a) Define Poisson bracket. State and prove Poisson's theorem. (7)

   b) Set up Hamilton-Jacobi equation for Hamilton's principal function. (8)

UNIT- III

5. a) What is Central force? How do you reduce the two-body problem into one body problem? (8)

   b) Explain classification of the orbits and arrive conditions for closed orbits of a particle moving under a gravitational force. (7)

OR

6. a) Derive the Rutherford's formula for scattering of α–particles by atomic nuclei. (7)

   b) Show that area swept out by the radius vector drawn from sun to the planet in equal times are equal. (8)

UNIT- IV

7. a) What are Euler's angles? Obtain an expression for the complete transformation matrix. (10)

   b) Define Inertia tensor. Give its physical significance. (5)

OR

8. a) Express angular momentum of a rigid body in terms of angular velocity and moment of inertia. (8)

Contd...2

b) Derive Euler's equations of motion for a rigid body. **(7)**

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PART – B **(5x2=10)**

Answer any TWO questions:

9. a) Write the Lagrange's equation of motion for Atwood's machine with m_1 and m_2 as masses suspended by a thread of length l that passes over a smooth fixed pulley.

b) Discuss harmonic oscillator as an example of a canonical transformation.

c) Derive the equations of motion for inverse square law force.

d) Write note on normal modes of vibration of the system.

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PH 573.1

Reg. No. | | | | | | |

St Aloysius College (Autonomous)

Mangaluru

Semester I – P.G. Examination – M.Sc. Physics

February 2021

CLASSICAL ELECTRODYNAMICS

Time: 3 Hours

Max. Marks: 70

PART - A

Answer all questions choosing one from each unit. (15x4=60)

UNIT -I

1. a) Define Gauss's Law in Electrostatics. Using this find the field outside a uniformely charged solid sphere of radius R and total charge q. (6)

   b) Obtain an expression for multipole expansion for a vector potential of a circular loop carrying current and hence prove that magnetic monopoles do not exist. (9)

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OR

2. a) What is Biot-Savart law? Explain with example. (6)

   b) Using the method of images, find the total charge induced on an infinite grounded conducting plane when a point charge Q is held at a distance d above it. (9)

UNIT -II

3. a) What is gauge transformation? Show that electric and magnetic fields are invariant under a gauge transformation. (7)

   b) Express Maxwell's equations in terms of scalar and vector potentials. (8)

OR

4. a) State and prove Poynting's theorem. (7)

   b) Obtain expressions for Liénard-Wiechert potentials for a moving point charge. (8)

UNIT -III

5. a) Discuss the propagation of plane electromagnetic waves in conducting media. (10)

   b) Explain the concept of skin depth. (5)

OR

6. a) Describe TE and TM modes of electromagnetic wave propagation in cylindrical waveguide. (10)

   b) Write a note on Q-factor of cavity resonator. (5)

UNIT -IV

7. a) What are Lorentz transformations? Explain. (5)

   b) Obtain the Lorentz transformations equation for the electric and magnetic fields. (10)

OR

8. a) Express the electromagnetic field in tensor notation. (9)

Contd...2

b) Explain the potential formulation of relativistic electrodynamics. (6)

PART - B

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Answer any TWO questions: **(5x2=10)**

9. a) Find the potential inside and outside a spherical shell of radius R that carries a uniform surface charge.

b) Write a note on Liénard-Wiechert potentials.

c) A rectangular waveguide operating in the TE mode, has the dimensions of 5 cmx3 cm. Calculate its cut off frequency for TE_{11} mode.

d) Write a note on Four-vector notations.

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Semester I – P.G. Examination – M.Sc. Physics

February 2021

ELECTRONICS

Time: 3 hrs. **Max Marks: 70**

PART - A

Answer all questions choosing ONE from each unit. **(15x4=60)**

UNIT- I

1. a) Sketch a comparator using op amp and explain its output for a sine wave input. **(7)**

b) What are active filters? Describe the working of low pass and high pass filters with relevant diagrams. **(8)**

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OR

2. a) With suitable circuit diagram explain the working of an instrumentation amplifier. Mention its application. **(6)**

b) What is feedback? Explain. Mention its types and describe the voltage series feedback with its circuit. **(9)**

UNIT- II

3. a) Describe the construction and characterization of a UJT. Explain the design of a relaxation oscillator. Derive the expression for its frequency of oscillation. **(10)**

b) What is the difference between the triangular and sawtooth waveforms? Using dual OPAMP circuit explain sawtooth wave generation. **(5)**

OR

4. a) Write the internal circuit diagram of IC 555 timer and explain the working of a monostable multivibrator. **(8)**

b) What is Phase Locked Loop (PLL)? Explain how the PLL can be used as frequency multiplier. **(7)**

UNIT- III

5. a) Explain the concept of class-A and class-B power amplification. Draw the circuit diagram of a class-B push-pull amplifier and explain the working. **(9)**

b) With the circuit diagram and waveform illustrate how AC power control is achieved using Silicon Controlled Rectifier. **(6)**

OR

6. a) What is signal conditioning and why it is required? Develop the block diagram of a DC signal conditioning system and explain the functions of each block. **(10)**

Contd...2

b) What are transducers? Define active and passive transducers. Explain passive transducers. **(5)**

UNIT- IV

7. a) What are synchronous and asynchronous counters? Explain decade counter using a relevant circuit diagram. **(10)**

b) With a diagram explain successive approximation ADC. **(5)**

OR

8. a) Explain general microprocessor architecture. **(8)**

b) Explain semiconductor memory. **(4)**

c) Discuss the theory and circuit of 2 to 4 line MUX. **(3)**

PART – B (5x2=10)

Answer any <u>TWO</u> questions:

9. a) Explain with the diagram how the OPAMP in the non-inverting configuration can be used as averaging amplifier.

b) Write a note on voltage controlled oscillator.

c) What is distortion in amplifier? Explain.

d) Explain how NAND gate works as a universal gate. Give an example.

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