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End Semester Examination of Semester–II, 2016
Subject : PHYSICS (PG)
Paper : PHSPG–201 (Theory)
Group : A & B
Full Marks : 40
Time : 2 Hrs

The figures in the margin indicate the marks corresponding to the question

Candidates are requested to give their answers in their own word as far as practicable.

Illustrate the answers wherever necessary.

Use separate Answer scripts for Group A and Group B

Group A : Full Marks 20

PHSPG–201(A) : Methods of Mathematical Physics

Answer Q1, and any one out of Q2 and Q3:

Q1. Answer any **five** question: 2x5=10

   i)   State Dirichlet and Neumann boundary value problems.

   ii)   If $\int\limits_{0}^{\infty} e^{-st} \cdot f(t)\,dt = \dfrac{3s-8}{4s^2+25}$, then find the function f(t).

iii) Find the Fourier transform of

$$f(x) = \begin{cases} x, & |x| \le a \\ 0, & |x| > a \end{cases}$$

iv) Find $L[2^t]$ when the Kernel is e^{-pt}.

v) Find the direct sum $A \oplus B \oplus C$ where

$$A = [a], \quad B = \begin{bmatrix} b & c \\ d & e \end{bmatrix} \quad \text{and} \quad C = \begin{bmatrix} f & g & h \\ i & j & k \\ l & m & n \end{bmatrix}$$

and show that the trace of the direct sum
= trace A + trace B + trace C.

vi) Let H be a subgroup of a group G. If $x^2 \in H$ for all $x \in G$, then prove that H is a normal subgroup of G.

vii) Define Lie group and give an example of it.

viii) If a group is defined as
a * b = a + b - 1.
Find the inverse of the group.

2. a) Use Laplace transform to solve the following differential equation

$$t\frac{d^2 y(t)}{dt^2} + \frac{dy(t)}{dt} + 4ty(t) = 0;$$

given that $y(0) = 3$ and $\left(\frac{dy(t)}{dt}\right)_{t=0} = 0.$

b) Find the particular integral of

$$\frac{\partial^2 z}{\partial x^2} + \frac{\partial^2 z}{\partial x \, \partial y} - 6\frac{\partial^2 z}{\partial y^2} = x^2 . \sin(x+y) \qquad 5+5$$

3. a) Evaluate $L^{-1}\left[\ln\left(1+\frac{\omega^2}{s^2}\right)\right]$.   5

b) State and prove Lagrange's theorem in group.   3

c) Construct a group (multiplication) table for the element $(1, -1, i, -i)$.   2

Group B : Full Marks 20

PHSPG 201(B) : Classical Mechanics–II & Basics of GTR
Answer Q1, and any one out of Q2 and Q3:

Q1. Answer **any five** question: 2x5=10

i) What do you mean by an orthogonal transformation?

ii) Show that any (0, 2) tensor can be written as sum of a symmetric and a skew-symmetric tensor of the same type.

iii) Find the equation of geodesic in a Minkowski spacetime.

iv) Show that C + C = C in special theory of relativity.

v) Writing the Minkowski metric in the (t, x, y, z) coordinates determine whether the separation of the events (−1, 1, −1, 1) and (4, 1, −1, 6) is timelike, spacelike or null.

vi) Show that the fundamental metric tensor g^{ij} is symmetric.

vii) Find the number of independent components of Rieamann-Christoffel tensor.

viii) Give an example of a non-holonomic constraint.

2. a) Show that if the rest mass of a particle is constant, then the Minkowski 4–force acting on it is orthogonal to the 4–velocity.

b) What do you mean by 'World point' and 'World line'?

c) Derive Newton's law of gravitation from Einstein's general relativistic equations in case of a static weak field.   4+2+4

3. a) Show that the real orthogonal matrix specifying the physical motion of a rigid body with one point fixed always has the eigenvalue +1.   4

b) Write down the expression for the Christoffel symbols of 2nd kind in a Riemannian space. Show that it is always possible to find a coordinates system in which all the components of the Christoffel symbols vanish at a given point.   2+4