St. Philomena's College (Autonomous), Mysore

Question Bank

Programme: M. Sc. Physics

III Semester

Course Title: Rotation and Lie Groups in Physics

Course Type: Soft Core

Q.P Code : 88336

Sl.No.	Module	Questions	Marks
1.	1	Define a group with examples.	5
2.	1	Show that the identity element and inverse of a group are unique.	5
3.	1	Define a groupoid and semigroup with examples.	5
4.	1	Prove that set of all complex square matrices form a group under multiplication.	5
5.	1	show that H={±1} is a subgroup of G={±1,±i}.	5
6.	1	show that set of all square matrices with determinant -1 does not form a subgroup of O(n,C).	5
7.	1	Show that z is the centre of group G if g⊂G and zg=gz.	5
8.	1	Evaluate eAθ if A^2=E and θ is a complex number.	5
9.	1	Evaluate eAθ if A^3=-E and θ is a complex number.	5
10.	1	Show that BAB^{-1} = exp(BAB^{-1}).	5
11.	1	If A and B are commuting matrices, prove that $e^A.e^B=e^{(A+B)}$.	5
12.	1	Prove that the eigenvalues of a rotation matrix are e^0 and $e^{\pm i\theta}$.	5
13.	1	Find the rotation matrix corresponding to a rotation through an angle of π rad about vector $\frac{1}{\sqrt{3}}(1,1,1)$.	5
14.	1	Discuss the commutation relations of generatrs of SO(3).	5

15.	1	What are equivalent and inequivalent representations of a group? Explan.	5
16.	1	Discuss the canonical form of a matrix representative.	5
17.	1	Explain in detail the direct sum of matrices.	5
18.	2	If G is a Lie group and G_0 the connected component of unity. Then justify that G_0 is a normal subgroup of G and is a Lie group itself. The quotient group G/G_0 is discrete.	5
19.	2	Define the structure constants and give their properties.	5
20.	2	List the matrix exponential properties of arbitrary nxn matrices.	5
21.	2	Define ideals and proper ideals and hence explain simple and semisimple lie algebras.	5
22.	2	Evaluate $[\sigma_x , \sigma_y]+[\sigma_y , \sigma_z][\sigma_z , \sigma_x]$.	5
23.	2	Show that the lie algebra of SO(3) is semisimple and its killing form is negative definite.	5
24.	1	Outline the classification of continuous matrix groups with an example for each category.	10
25.	1	Explain the properties of different types of orthogonal groups.	10
26.	1	Obtain the rotation matrix interms of axis and angle.	10
27.	1	Obtain the matrix representative of $R(n, \theta)$ in the basis {i,j,k} of R^3.	10
28.	1	Discuss in detail the properties of rotation matrix.	10
29.	1	Prove that the matrix series converges for a finite n.	10
30.	1	Obtain the Euler resolution of rotation matrix in terms of the angles α,β,γ.	10
31.	1	Calculate the generators of SO(3) and discuss their properties.	10
32.	1	Explain the homomorphism of a group with example and show that the kernal of is a subgroup.	10

33.	1	Define the representation of an abstract group and hence explain faithful, unfaithful and Character of representation.	10
34.	1	Distinguish between reducible and irreducible representations of a group. Show that the 2dimensional representations of Pauli's spin matrices are irreducable.	10
35.	1	State and explain the Schur's lemma. Obtain the orthogonality relations for irreducible representations.	10
36.	1	Construct the D1/2 representations of SO(3) by exponentiation.	10
37.	1	Obtain the representations of D1/2 matrices for arbitrary angles.	10
38.	2	Define a Lie group and explain its topological properties with examples	10
39.	2	Explain the algebraic and topological properties of a lie group.	10
40.	2	Define the generators of a lie group.	10
41.	2	Define and explain the properties of a lie algebra.	10
42.	2	Explain a killing form. Show that a lie algrbra is semisimple if the determinant of the killing form is non-zero.	10
43.	2	Explain in detail how the Dynkin diagram of a semi-simple Lie algebra is constructed.	10
44.	2	Give the generators for the Lie group SU (2) and discuss their Lie algebra.	10
45.	2	State and prove the Baker-Campbell-Hausdorff formula for non comuting operators.	10

For 2 credit soft core courses

St. Philomena's College(Autonomous), Mysuru		
I/II/III/IV Semester M.Sc. Examination Month – Year		
Subject:		
Title:		
Time: 3 hours		**Max. Marks:70**
Instruction: Answer any four full question from Section – A and any of the five questions from Section – B.		
Section - A		
1.	Question to be asked from unit I	**05**
2.	Question to be asked from unit I	**05**
3.	Question to be asked from unit I	**05**
4.	Question to be asked from unit II	**05**
5.	Question to be asked from unit II	**05**
6.	Question to be asked from unit II	**05**
Section - B		
7.	Question to be asked from unit I	**10**
8.	Question to be asked from unit I	**10**
9.	Question to be asked from unit I	**10**
10.	Question to be asked from unit II	**10**
11.	Question to be asked from unit II	**10**
12.	Question to be asked from unit II	**10**

Note : Marks of Section A and B can be any combinations of 5 and 10 respectively. For example in section – A we may have (3+2). In section-B we may have (6+4) and (5+5).