SACRED HEART COLLEGE (AUTONOMOUS)

Department of Physics

M.Sc. Physics

COURSE PLAN

Semester 2

2016 - 17

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	2
COURSE CODE AND TITLE	16P2PHYT05: MATHEMATICAL METHODS IN PHYSICS – II	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	NAVYA S L		

COURSE OBJECTIVES
To explain the concepts of different mathematical methods in physics
To solve different physical problems.
To summarize the concepts of group theory
To apply the concepts of partial differential equations to solve physical problems

SESSION	TOPIC	LEARNING RESOURCES	REMARKS
	MODULE I		
1& 2	Functions of a complex variable - Analytic functions	Lect+ discussion	
3 & 4	Cauchy-Riemann equation , Problems	Lect+ discussion	
5 & 6	integration in a complex plane	Lect	
7 & 8	Cauchy's theorem-deformation of contours, problems	Lect+ discussion	
9 & 10	Cauchy's integral formula, problems	Lect + discussion	
11 & 12	Taylor and Laurent expansion-poles	Lect	
13 & 14	residue and residue theorem, problems	Lect	
15	Problems	discussion	
16, 17	Cauchy's Principle value theorem - Evaluation of integrals	Lect	
18	problems	Lect+ Group Activity	
	MODULE II		
19	Introduction to Fourier series and Fourier integral form	Lect	
20 & 21	Fourier transform - square wave, full wave rectifier and finite wave train	Lect	
22	problems	Group discussion	
23	momentum representation of hydrogen atom ground state and harmonic oscillator	Lect	
24& 25	Laplace transform –inverse Laplace transform	Lect	
26	problems	Group discussion	
27, 28& 29	properties and applications	Lect	
30	Problems	Group discussion	
31 & 32	Earth's nutation, LCR circuit	Lect	
33	wave equation in a dispersive medium	Lect + discussion	
34	damped, driven oscillator	Lect	
35	solution of differential equations.	Lect + discussion	
36	problems	Group discussion	
	MODULE III		
37	Introductory definition and concepts of group	Lect	
38 & 39	point group, cyclic group, homomorphism and isomorphism	Lect + discussion	
40	classes, reducible and irreducible representations	Lect + discussion	
41 & 42	Schur's Lemmas and Great Orthogonality theorem	Lect + discussion	
43 & 44	Group character table	Lect + discussion	
45& 46	C2V, C3V and C4V groups	Lect + discussion	
47	Lie group, concept of generators	Lect + discussion	
48 & 49	rotation group SO(2), SO(3)	Lect.	
50& 51	Unitary Group SU(2) and SU(3)	Lect	

52 & 53	Homomorphism between SU(2) and SO(3)	Lect	
54	– Irreducible Representation of SU(2).	Lect + discussion	
MODULE IV			
55	Characteristics and boundary conditions for partial differential equations	seminar + discussion	
56 & 57	Nonlinear partial differential equations – separation of variables	seminar + discussion	
58 & 59	cylindrical and spherical polar coordinates	seminar + discussion	
60 & 61	Heat equation, Laplace's equation	seminar + discussion	
62	Poisson's equation	seminar + discussion	
63 & 64	Nonhomogeneous equation - Green's function	seminar + discussion	
65 & 66	symmetry of Green's function	seminar + discussion	
67 & 68	Green's function for Poisson equation	seminar + discussion	
69 & 70	Laplace equation and Helmholtz equation	seminar + discussion	
71	Application of Green's function in scattering p Problems	seminar + discussion	
72	Problems	Group Activity	

INDIVIDUAL ASSIGNMENTS/SEMINAR – Details & Guidelines

	Date of completion	Topic of Assignment & Nature of assignment (Individual/Group – Written/Presentation – Graded or Non-graded etc)
1	Before 1st Internal	Individual- Graded – 3 sets
2	Before 2nd Internal	Individual- Graded -3 sets

ASSIGNMENTS– Details & Guidelines – Will be notified prior to the announcement of the assignment – marks will be scaled to 5.

SEMINARS will be given to each student (20 mins duration) – 5 marks ()

Basic Reference:

1) Mathematical Methods for Physicists, G.B. Arfken&H.J. Weber 4th Edition, Academic Press.
2) Mathematical Physics, H.K Dass& Dr. Rama Verma, S. Chand &Co.

Reference Books:

1. Mathematical methods in Classical andQuantum Physics, T. Dass& S. K. Sharma, Universities Press (2009)

2. Introduction to Mathematical physics,Charlie Harper, PHI

3. Fundamentals of Statistical and Thermal Physics, F. Rief, McGraw Hill (1986).

4. Mathematical Physics, B.D. Gupta, VikasPub.House, New Delhi

5. Elements of Group Theory for Physicists, A.W. Joshi, New Age India 2) Mathematical Physics, Sathyaprakash, Sultan Chand & Sons, New Delhi.

6. Group theory- Schaum’s series, Benjamin Baumslag& Bruce Chandler, MGH.

7. Mathematical Physics, B.S Rajput, PragatiPrakashan

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	2
COURSE CODE AND TITLE	16P2PHYT06: Quantum mechanics - 1	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	Dr. Jimmy Sebastian		

COURSE OBJECTIVES
To define the formalism of Non relativistic Quantum Mechanics.
To demonstrate principles of quantum mechanics.
To apply the principles of quantum mechanics to specific quantum mechanical systems.
To solve specific problems in quantum mechanics

Session	Topic	Learning Resources	Remarks
	MODULE - I		
1	Introduction to Quantum Mechanics	PPT talk and interaction	
2	Inadequacy of Classical Mechanics	PPT + Demonstration using examples	
3	Stern - Gerlach experiment leading to vector space concept	Lecture + question answer session.	
4	Dirac notation for state vectors- ket space, bra space, inner products	Lecture + question answer session.	
5	Algebraic manipulation of operators – unitary operators, eigenkets and eigenvalues	Lecture + question answer session.	
6	Hermitian operators - concept of complete set	Lecture + question answer session.	
7	Representation of an operator by square matrix	Lecture + question answer session.	
8	Matrix elements of an operator expectation values of Hermitian and anti -Hermitian operators	Lecture + question answer session.	
9	Generalized uncertainty product - change of basis - orthonormal basis and unitary matrix.	Lecture + question answer session.	
10	Transformation matrix unitary equivalent observables - eigenkets of position	Lecture + question answer session.	
11	Infinitesimal operator and its properties – linear momentum as generator of translation.	Lecture + question answer session.	
12	Canonical commutation relations – properties of wave function in position space and momentum space.	Lecture + question answer session.	
13	Relations between operator formalism and wave function formalism - momentum operator in position basis.	Lecture + question answer session.	
14	Momentum space wave function – computation of expectation values x, x^2, p and p^2 for a Gaussian wave packet.	Lecture + question answer session.	
15	Problem set discussion and revision.	discussion	
	MODULE - II		

16	Time evolution operator and its properties-	Lecture + question answer session.	
17	Schrodinger equation for the time evolution operator.	Lecture + question answer session.	
18	Energy eigenkets - time dependence of expectation values	Lecture + question answer session.	
19	Time energy uncertainty relation	Teacher student interactive session	
20	Schrodinger picture and Heisenberg picture	Lecture + question answer session.	
21	Behaviour of state kets and observables in Schrodinger picture and Heisenberg picture.	Lecture + question answer session.	
22	Heisenberg equation of motion - Ehrenfest's theorem	Lecture + question answer session.	
23	Time evolution of base kets	Lecture + question answer session.	
24	Transition amplitude	Lecture + question answer session.	
25	Simple harmonic Oscillator - 1	Lecture + question answer session.	
26	Simple harmonic Oscillator - 2	Lecture + question answer session.	
27	Simple harmonic Oscillator - 3	Lecture + question answer session.	
28	CIA -1	Exam	
29	Pictures in quantum mechanics (Revision)	Lecture + question answer session.	
	MODULE - III		
30	Commutation relation between infinitesimal rotations.	Lecture + question answer session.	
31	Infinitesimal rotations in quantum mechanics	Lecture + question answer session.	
32	Fundamental commutation relations of angular momentum	Lecture + question answer session.	
33	Rotation operator for spin ½ system.	Lecture + question answer session.	

34	Pauli two component formalism	Lecture + question answer session.	
35	Pauli spin matrices	Lecture + question answer session.	
36	2x2 matrix representation of rotation operator.	Lecture + question answer session.	
37	Commutation relations for J^2, J_x	Lecture + question answer session.	
38	Eigenvalues of J^2 and J_x	Lecture + question answer session.	
39	Matrix elements of angular momentum operators	Lecture + question answer session.	
40	Representation of the rotation operator	Lecture + question answer session.	
41	Rotation matrix	Lecture + question answer session.	
42	Properties of the rotation matrix	Lecture + question answer session.	
43	Orbital angular momentum as a rotation generator	Lecture + question answer session.	
44	Addition of angular momentum and spin angular momentum.	Lecture + question answer session.	
45	Addition of spin angular momenta.	Lecture + question answer session.	
46	Clebsch-Gordon coefficients.	Lecture + question answer	
47	Clebsch-Gordon coefficients for two spin ½ particles.	Lecture + question answer session.	
48	Problems on CG coefficients.	Discussion	
49	Revision of Basics of Quantum Mechanics	Discussion	
50	Revision of Quantum Dynamics	Discussion	
51	Revision of angular momentum	Discussion	
52	Simple Harmonic oscillator – an analysis.	Lecture + question answer session.	
	MODULE - IV		

53	Motion in a central potential - 1	Lecture + question answer session.	
54	Motion in a central potential - 2	Lecture + question answer session.	
55	Motion in a central potential – 3	Problem solving session.	
56	Motion in a central potential - 4	Lecture + question answer session.	
57	Hydrogen atom problem - 1	Lecture + question answer session.	
58	Hydrogen atom problem - 2	Lecture + question answer session.	
59	Hydrogen atom problem - 3	Lecture + question answer session.	
60	CIA - 2	Exam	
61	WKB approximation	Lecture + question answer session.	
62	WKB approximation -2	Lecture + question answer session.	
63	WKB wave function	Lecture + question answer session.	
64	Validity of the approximation	Lecture + question answer session.	
65	Variational methods	Lecture + question answer session.	
66	Variational methods - bound states	Lecture + question answer session.	
67	Variational methods - harmonic oscillator	Lecture + question answer session.	
68	Perturbation theory	Lecture + question answer	
69	Stationary state perturbation theory	Lecture + question answer session.	
70	Perturbation theory - non degenerate case	Lecture + question answer session.	

71	Recap on Approximation methods	Discussion	
72	Recap on nonrelativistic quantum mechanics.	Discussion	

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SEMINARS will be given to each student (20 mins duration) – 5 marks (,)

Text

1. Modern Quantum Mechanics, J. J. Sakurai, Pearson Education (Chapter 1)

2. Quantum mechanics, V.K. Thankappan New Age International 1996 (Chapter 4, 8)
3. Quantum Mechanics, G Aruldhas, PHI, 2002, (Chapter 10)

Reference Books:

1. A Modern approach to quantum mechanics, John S. Townsend, Viva Books MGH.
2. Quantum Mechanics, Concepts and Applications, N. Zettily, John Wiley & Sons
Quantum Mechanics, L.I. Schiff, Tata McGraw Hill

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	2
COURSE CODE AND TITLE	16P2PHYT07- Condensed Matter Physics	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	Dr. Sumod S G		

COURSE OBJECTIVES
To apply the concept of X-ray diffraction to interpret crystalline structure.
To compare different solids using band theory.
To analyse various dielectric and magnetic properties of crystals
To describe the latest trends in Nanotechnology

SESSION	**TOPIC**	**LEARNING RESOURCES**	**REMARKS**
	MODULE I		
1	**Elements of Crystal Structure (6 Hrs)** Review of crystal lattice fundamentals	Lect	
2	and interpretation of Bragg's equation,	Lect	
3	Ewald construction, the reciprocal lattice,	Lect	
4	reciprocal lattice to SC, BCC and FCC lattices, properties of reciprocal lattice	Lect	
5	, diffraction intensity - atomic, geometrical	Lect	
6	crystal structure factors- physical significance. Elements of Crystal Structure	Lect	
7	Review of Drude-Lorentz model -	Lect+ Group Activity	

8	electrons moving in a one dimensional potential well - three dimensional well -	Lect	
9	quantum state and degeneracy -	Lect	
10	density of states - Fermi-Dirac statistics -	Lect	
11	effect of temperature on Fermi-Dirac distribution -	Lect	
12	electronic specific heat -	Lect	
13	electrical conductivity of metals -	Lect	
14	relaxation time and mean free path -	Lect	
15	electrical conductivity and Ohm's law	Lect	
16	- Widemann-Franz-Lorentz law -	Lect	
15	electrical resistivity of Metals	Lect	
17	Problems	Lect	
18	Revision	Lecture+Activity	
MODULE II			
19	Bloch theorem -	PPT+SEMINAR+class activity	
20	Kronig-Penney model -	PPT+SEMINAR+class activity	
21	Brillouin zone construction of Brillouin zone in one and two dimensions –	PPT+SEMINAR+class activity	
22	extended, reduced and periodic zone scheme of Brillouin zone (qualitative idea only)	Group Activity	

23	- effective mass of electron	PPT+SEMINAR+class activity	
24	- nearly free electron model – conductors - semiconductors - insulators.	Lect.	
25	Generation and recombination -	Lect	
26	minority carrier life-time -	Lect	
27	mobility of current carriers -	Lect	
28	drift and	Lect	
29	diffusion -	Lect.	
30	general study of excess carrier movement-	Lect	
32	diffusion length.	Lect	
33	Derivation of diffusion length	Lect	
34	Problems	PPT+SEMINAR+class activity	
MODULE III			
35	Vibrations of crystals with monatomic basis –	Lect	
36	diatomic lattice –	Lect.	
37	quantization of elastic waves	Lect	
38	– phonon momentum.	Lect	
39	Anharmonicity and thermal expansion -	Lect	
40	specific heat of a solid - classical model -	Lect	
41	Einstein model -	Lect.	

42	density of states -	Lect	
43	Debye model	Lect	
44	- thermal conductivity of solids -	Lect	
45	thermal conductivity due to electrons	Lect	
46	and phonons	Lect.	
47	- thermal resistance of solids.	Lect	
48	Problems	Lect	
49	Review of basic terms and relations,	Lect	
50	ferroelectricity,	Lect	
51	hysteresis,	Lect.	
52	dipole theory -	Lect	
53	Curie- Weiss law,	Lect	
54	classification of ferroelectric materials	Lect	
	and piezoelectricity Ferroelectric domain,	Lect	
	. antiferroelectricity and ferrielectricity	Lect	
	MODULE IV		
56	Review of basic terms and relations, Quantum theory of paramagnetism -	Lect	
57	cooling by adiabatic demagnetization –	PPT+SEMINAR+class activity	
58	Hund’s rule – ferromagnetism -		

59	spontaneous magnetization in ferromagnetic materials -	PPT+SEMINAR+class activity	
60	Quantum theory of ferromagnetism –	PPT+SEMINAR+class activity	
61	Weiss molecular field - Curie- Weiss law-spontaneous magnetism	PPT+SEMINAR+class activity	
62	internal field and exchange interaction – magnetization curve – saturation magnetization - domain model.	Lect.	
63	Thermodynamics and electrodynamics of superconductors-	Lect	
64	BCS theory- flux quantization-	Lect	
65	single particle tunneling- Josephson superconductor tunneling-	Lect	
66	macroscopic quantum interference	Lect	
67	Properties of metal, semiconductor,		
68	rare gas and molecular nanoclusters-superconducting fullerene-	Lect.	
69	quantum confined materials-quantum wells, wires, dots and rings-	Lect	

70	metamaterials-	Lect	
71	graphene	Lect	
72	Problems and Revision	Lect	

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Basic Reference:

1. 1. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. 2010
2. Introduction to Nanotechnology, Charles P Poole and Frank J Owens, Wiley India (Chapter 4, 5, 9)
3. Introduction to Solid State Physics, C. Kittel, 3rd Edn. Wiley India. .
4. Solid State Physics, S.O. Pillai, New Age International 6th Edn. 2010,

Reference Books:

1. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Cengage Learning Pub.11th Indian Reprint (2011).
2. Solid State Physics, R.L. Singhal, Kedar Nath Ram Nath & Co (1981)
3. Elementary Solid State Physics, M. Ali Omar, Pearson, 4th Indian Reprint (2004).
4. Solid State Physics, C.M. Kachhava, Tata McGraw-Hill (1990).

5. Elements of Solid State Physics, J. P. Srivastava, PHI (2004)

6. Solid State Physics, Dan Wei, Cengage Learning (2008)

7. Solid State Physics, A.J. Dekker, Macmillan & Co Ltd. (1967)

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	2
COURSE CODE AND TITLE	16P2PHYT08: Thermodynamics and Statistical Mechanics	CREDIT	3
Theory HOURS/WEEK	3	HOURS/SEM	54
FACULTY NAME	Dr. Roby Cherian		

COURSE OBJECTIVES
To summarize the concepts of thermodynamics and probability.
To illustrate the foundations of Statistical mechanics
To model the problems related to Canonical and Grand Canonical ensemble
To interpret the concepts of Phase Transitions

SESSION	TOPIC	LEARNING RESOURCES	REMARKS
	MODULE I		
1	Fundamental definitions	Lect	
2	Thermodynamic potentials, Maxwells relations	Lect	
3	Approach to equilibrium	Lect	
4	Ideas of Probability- classical and statistical, axioms of probability	Lect	
5	Independent events – counting the number of events	Lect	
6	Basic ideas of statistical mechanics	Lect	
7	Definition of quantum state	Lect	
8	Model of spins on lattice	Lect	
9	EOS	Lect	
10	EOS	Lect	
11	Problems	Lect+ Group Activity	

MODULE II			
12	The second law of thermodynamics	Lect	
13	Canonical Ensemble – Introduction	Lect	
14	Partition function	Lect	
15	Entropy in Canonical ensemble	Lect	
16	Bridging thermodynamics via Partition function	Lect	
17	Condition for thermal equilibrium	Lect	
18	Case study	Lect	
19	Particle in a box 1D	Lect	
20	Particle in a box 3D	Lect	
21	Heat and work	Lect	
22	Rotational energy levels	Lect	
23	Vibrational energy levels	Lect	
24	Equipartition theorem, minimizing free energy	Lect	
25	Identical particles-symmetric and ant symmetric wavefunctions	Lect	
26	Bosons, fermions	Lect	
27	Calculating Z	Lect	
28	Spins on lattice	PPT+SEMINAR+class activity	
MODULE III			
29	DOS	PPT+SEMINAR+class activity	
30	DOS- cont.	PPT+SEMINAR+class activity	
31	Maxwell speed distribution	PPT+SEMINAR+class activity	
32	Problems	Group Activity	
33	Black body radiation	PPT+SEMINAR+class activity	

34	Rayleigh jeans theory	PPT+SEMINAR+class activity	
35	Plancks distribution	PPT+SEMINAR+class activity	
36	Free energy	PPT+SEMINAR+class activity	
37	Grand Canonical ensemble	Lect.	
38	Condition for chemical equilibrium	Lect	
39	Approach to chemical equilibrium	Lect	
40	Grand Canonical partition function	Lect	
41	Grand Potential	Lect	
29	DOS	PPT+SEMINAR+class activity	
30	DOS- cont.	PPT+SEMINAR+class activity	
31	Maxwell speed distribution	PPT+SEMINAR+class activity	
32	Problems	Group Activity	
33	Black body radiation	PPT+SEMINAR+class activity	
34	Rayleigh jeans theory	PPT+SEMINAR+class activity	
35	Plancks distribution	PPT+SEMINAR+class activity	
36	Free energy	PPT+SEMINAR+class activity	
37	Grand Canonical ensemble	Lect.	
38	Condition for chemical equilibrium	Lect	
39	Approach to chemical equilibrium	Lect	
40	Grand Canonical partition function	Lect	
41	Grand Potential	Lect	
MODULE IV			
42	Fermi systems	Lect	

43	Bose Systems	Lect	
44	Examples	PPT+SEMINAR+class activity	
45	Examples	PPT+SEMINAR+class activity	
46	Phases- thermodynamic potential	Lect	
47	1st order phase transitions	Lect	
48	Clapeyron equations	Lect	
49	Phase seperation	Lect	
50	Phase separation Cont.	Lect	
51	Problems	Group Activity	
52	Problems	Group Activity	
53	Problems	Group Activity	
54	Problems	Group Activity	

INDIVIDUAL ASSIGNMENTS/SEMINAR – Details & Guidelines

	Date of completion	Topic of Assignment & Nature of assignment (Individual/Group – Written/Presentation – Graded or Non-graded etc)
1	Before 1st Internal	Individual- Graded – Best of 2 sets
2	Before 2nd Internal	Individual- Graded –Best of 2 sets

ASSIGNMENTS– Details & Guidelines – Will be notified prior to the announcement of the assignment – marks will be scaled to 5.

SEMINARS will be given to each student (20 mins duration) – 5 marks ()

Basic Reference:

1. Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2ndEdn. 2007,

Reference Books:

1. Statistical Mechanics, R.K. Pathria, & P.D. Beale, 2nd Edn, B-H (Elsevier) (2004).
2. Introductory Statistical Physics, S.R.A. Salinas, Springer (2000).
3. Fundamentals of Statistical and Thermal Physics, F. Rief, McGraw Hill (1986).
4. Statistical Mechanics, Kerson Huang, John Wiley and Sons (2003).

5. Statistical Mechanics, Satyaprakash& Agarwal, KedarNath Ram Nath Pub. (2004).

6. Problems and solutions on Thermodynamics and Statistical mechanics, Yung Kuo Lim, World Scientific Pub. (1990)

7. Fundamentals of Statistical Mechanics, A.K. Dasgupta, New Central Book Agency Pub. (2005)

8. Statistical Mechanics: a survival guide, A.M. Glazer and J.S. Wark, Oxford University Press. (2001).