SACRED HEART COLLEGE (AUTONOMOUS)

Department of Physics

M.Sc. Physics

COURSE PLAN

Semester-3

2015 - 16

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	3
COURSE CODE AND TITLE	P3PHYT09: Quantum mechanics -II	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	Dr. Jimmy Sebastian		

Course Objective:

- To define the formalism of time dependent perturbation theory, scattering theory in the framework of non-relativistic Quantum Mechanics.
- To explain the fundamentals of scattering theory, relativistic quantum theory and quantum field theory.
- To apply non relativistic quantum theory to systems under perturbation and quantum mechanical bodies undergoing scattering. Apply relativistic quantum mechanics to quantum mechanical systems.
- To solve specific problems in non-relativistic and relativistic quantum mechanics.

Sessions	Topic	Learning Resources
1	Introduction to time independent quantum mechanics	PPT talk and interaction with students.
2	Cases when potential is time dependent.	Lecture + Interaction
3	Time dependent potentials	Lecture + Interaction
4	interaction picture	Lecture + Interaction
5	time evolution operator in interaction picture	Lecture + Interaction
6	time dependent perturbation theory	Lecture + Interaction
7	Dyson series – transition probability	Lecture + Interaction
8	constant perturbation	Lecture + Interaction
9	Fermi-Golden rule	Lecture + Interaction
10	Harmonic perturbation	Lecture + Interaction
11	interaction with classical radiation field	PPT + Lecture
12	absorption and stimulated emission	Lecture + Interaction
13	electric dipole approximation	Lecture + Interaction
14	photo electric effect	Lecture + Interaction
15	energy shift and decay width	Lecture + Interaction
16	sudden and adiabatic approximation	Lecture + Interaction
17	Scattering theory - introduction	PPT + Lecture
18	Difference between classical collision and quantum mechanical scattering.	Discussion
19	Asymptotic wave function and differential cross section -1	Lecture + Interaction
20	Asymptotic wave function and differential cross section -2	Lecture + Interaction
21	Born approximation -1	Lecture + Interaction
22	Born approximation -1	Lecture + Interaction
23	Application of Born approximation, Yukawa potential - Rutherford scattering	Lecture + Interaction
24	The partial wave expansion -1	Lecture + Interaction

25	The partial wave expansion -2	Lecture + Interaction
26	The partial wave expansion -3	Lecture + Interaction
27	hard sphere scattering	Lecture + Interaction
28	S-wave scattering for the finite potential well,	Test
29	Resonances – in scattering	Lecture + Interaction
30	Ramsaur- Townsend effect	Lecture + Interaction
31	Problems on born approximation	Interactive session
32	Problems in partial wave analysis	Interactive session
33	Revision of Scattering theory.	Interactive session
34	Revision of scattering theory	Interactive session
35	1st CIA	Exam
36	Relativistic Quantum Mechanics – Why do we need it?	Lecture + Interaction
37	How Schrodinger equation fails in relativistic quantum mechanics.	Lecture + Interaction
38	Four vector space, covariant notation	Lecture + Interaction
39	Klein-Gordon equation	Lecture + Interaction
40	Probability conservation	Lecture + Interaction
41	derivation of Dirac equation-1	Lecture + Interaction
42	derivation of Dirac equation-2	Lecture + Interaction
43	conserved current representation	Lecture + Interaction
44	large and small components	Lecture + Interaction
45	approximate Hamiltonian for electrostatic problem -1	Lecture + Interaction
46	approximate Hamiltonian for electrostatic problem-2 explain the terms of the Hamiltonian.	Lecture + Interaction
47	free particle at rest. p = 0	Lecture + Interaction
48	plane wave solutions, p not zero	Interactive session
49	gamma matrices and its properties	Lecture + Interaction
50	relativistic covariance of Dirac equation	Lecture + Interaction
51	Angular momentum as constant of motion.	Lecture + Interaction
52	Revision of relativistic quantum mechanics	Interactive session
53	Problem solving assignment in the class	Interactive session

54	Question answer session	Interactive session
55	Classical field theory- introduction	Interactive session
56	Why quantum field theory is important.	Lecture + Interaction
57	Euler-Lagrange equation for fields	Lecture + Interaction
58	Hamiltonian formulation	Lecture + Interaction
59	functional derivatives conservation laws for classical field theory	Lecture + Interaction
60	Noether's theorem	Lecture + Interaction
61	Non relativistic quantum field theory	Lecture + Interaction
62	quantization rules for Bose particles-1	Lecture + Interaction
63	quantization rules for Bose particles-2	Lecture + Interaction
64	quantization rules for Fermi particles	Lecture + Interaction
65	relativistic quantum field theory	Lecture + Interaction
66	quantization of neutral Klein Gordon field (briefly)	Lecture + Interaction
67	canonical quantization of Dirac field	Lecture + Interaction
68	plane wave expansion of field operator	Lecture + Interaction
69	positive definite Hamiltonian	Lecture + Interaction
70	Recap of quantum field theory	Interactive session
71	Assignment on quantum field theory	Interactive session
72	2^{nd} CIA	Exam

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

Text

1. Modern Quantum Mechanics, J. J. Sakurai, Pearson Education (Chapter 1)
2. A Modern Approach to Quantum Mechanics, John S. Townsend, Viva Books Pvt Ltd, MGH (Chapter 13)
3. Advanced Quantum Mechanics, J.J. Sakurai, Pearson Education (Chapter 3)
4. Field Quantization, W Greiner , J Reinhardt, Springer, (Chapter 2, 3, 4 & 5)
5. Quantum Mechanics, G Aruldhas, PHI, 2002, (Chapter 10)

Reference Books:

1. Quantum Field Theory, Lewis H. Ryder, Academic Publishers,
2. Quantum Field Theory, Claude Itzykson& Jean Bernard Zuber, MGH, 1986
3. Introduction to Quantum Field Theory, S.J. Chang, World Scientific, 1990
4. Quantum Field Theory, Franz Mandl & Graham. Shaw, Wiley 1990

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	3
COURSE CODE AND TITLE	P3PHYT10: Computational Physics	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	Dr. Roby Cherian		

Course Objective:

- To explain the basic idea about the techniques used in curve fitting and interpolation
- To evaluate the basic idea about the computational techniques used in Numerical Differentiation and Integration
- To explain the basic idea about the computational techniques used in solving Ordinary Differential equation and System of Equations
- To explain the basic idea about the computational techniques used in solving Partial Differential Equation

SESSION	TOPIC	LEARNING RESOURCES
	MODULE-1	
1.	Introduction to the Course	Lect + Video
2.	Least Square Fit	Lect
3.	Non-Linear Fit - parabola, power	Lect
4.	Problem solving session on linear regression and non-linear fit	Activity
5.	Non-Linear Fit - exponential curves	Lect
6.	Problem solving session on linear regression and non-linear fit	Activity
7.	Introduction to Operators-1	Lect
8.	Problem solving session on Operators	Activity

9.	Introduction to Operators-2	Lect
10.	Introduction to Operators-3	Lect
11.	Problem solving session on Operators	Activity
12.	Introduction to Interpolation, Errors involved in Polynomial Interpolation	Lect
13.	Interpolation- Newtons Forward Interpolation	Lect
14.	Interpolation- Newtons Backward Interpolation	Lect
15.	Lagranges interpolation method, unevenly spaced data points	Lect
16.	Newtons divided difference method, Unevenly spaced data points	Lect
17.	Quiz activity	Activity
18.	Cubic Spline interpolation	Lect
19.	Statistical Test	Lect
20.	Problem solving session	Activity
	MODULE-II	
21.	Numerical Differentiation Introduction	Lect
22.	Numerical Differentiation Continued	Lect
23.	Numerical Differentiation Assignment	Activity
24.	Errors in Numerical Differentiation + Assignment (Class Activity)	Activity
25.	Cubic Spline Differentiation Assignment	Activity
26.	finding maxima and minima of a tabulated function	Lect + Activity
27.	NumericalIntegration General Trapezoidal	Lect
28.	Trapezoidal Error	Lect
29.	CIA-1	Internal Exam
30.	CIA-1 solution discussion	Activity

31.	Simpsons1/3 rule and Error	Lect + Activity
32.	Simpsons3/8 and its Error	Lect + Activity
33.	Romberg Integration	Lect + Activity
34.	Gaussian Integration	Lect + Activity
35.	Double Integration	Lect + Activity
36.	Monte Carlo – Intro + Assignment	Lect + Activity
	MODULE III	
37.	Introduction to Numerical Solution of Ordinary Differential Equations	Lect + Activity
38.	Euler method	Lect + Activity
39.	modified Euler method	Lect + Activity
40.	Runge - Kutta 4th order methods	Lect + Activity
41.	adaptive step size R-K method	Lect + Activity
42.	Problem solving	Activity
43.	Adam Moulton – ODE PC method	Lect + Activity
44.	Milnes Method – ODE PC method	Lect + Activity
45.	GaussElimination	Lect + Activity
46.	Gauss Jordan Elimination Method	Lect + Activity
47.	LU Decomposition	Lect + Activity

48.	Iterative method –Solving System of Equation- Gauss Jordan Method	Lect + Activity
49.	Iterative method –Solving System of Equation- Gauss Siedel Method	Lect + Activity
50.	Class assignment	Activity
51.	Matrix Inverse- Gauss Method	Lect + Activity
52.	Matrix Inverse- Gauss Jordan	Lect + Activity
53.	Class Activity and Assignment on recapping on Matrix, Eigen values and Eigen Vectors.	Lect + Activity
54.	Revising Matrix- Eigen values and Eigen Vectors and its Properties	Lect + Activity
55.	Power Method theory and Algorithm Example trying in class	Lect + Activity
56.	Example on Power method	Lect + Activity
57.	Jacobii Method Eigen Values and Eigen Vectors Theory	Lect + Activity
58.	Jacobii Method Eigen Values and Eigen Vectors Example	Lect + Activity
59.	CIA-2	Internal Exam
60.	CIA-2 – Solution discussion	Activity
	MODULE-IV	
61.	Intro to PDE, class activity Assignment	Lect + Activity
62.	Finite Difference method Part-1	Lect + Activity
63.	Finite Difference method Part-2	Lect + Activity
64.	PDE- Diffusion Equation- Explicit method –Schmidt Method – Class Activity	Lect + Activity
65.	Implicit scheme- PDE Classic and Crank Nicolson Method	Lect + Activity

66.	Class activity Examples on Implicit Methods	Lect + Activity
67.	Concept of Stability – reference given for Assignment	Lect
68.	Laplace Equation – Standard 5 point, Diagonal 5 point and nine point formula.	Lect + Activity
69.	Iterative Methods for solving Laplace and Few Problems	Lect + Activity
70.	Problem solving	Activity
71.	Problem Solving	Activity
72.	Problem Solving	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:

Text Books:

1. Mathematical Methods, G. Shanker Rao, K. Keshava Reddy, I.K. International Publishing House, Pvt. Ltd.

2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd.

Reference Books:

1. An Introduction to Computational Physics, Tao Pang, Cambridge University Press

2. Numerical methods for scientific and Engineering computation M.K Jain,S.R.K Iyengar, R.K. Jain, New Age International Publishers

3. Computer Oriented Numerical Methods, V. Rajaraman, PHI, 2004.

4. Numerical Methods, E. Balagurusami, Tata McGraw Hill, 2009.

5. Numerical Mathematical Analysis, J.B. Scarborough, 4th Edn, 1958

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	3
COURSE CODE AND TITLE	P3PHYT11 : MICROELECTRONICS AND SEMICONDUCTORDEVICES	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	Dr. Siby Mathew		

Course Objective:

- To identify mechanism to handle processes, memory, I/O devices, and files and develop an appropriate algorithm and the basic ideas about microprocessors
- To discuss issues of Process Management including process structure, the basic idea about various IC s like 8085,8086 etc
- To differentiate type of memory management techniques used in microcontrollers and 8051 architecture
- To appreciate the need and applications in the study of Schottky barrier diode

SESSION	TOPIC	LEARNING RESOURCES
1.	Microcomputer hardware system	PPT talk and interaction
2.	– memory organization –	PPT + Demonstration using examples
3.	main memory array –	Lecture + question answer session.
4.	memory management –	Lecture + question answer session.
5.	cache memory -	Lecture + question answer session.
6.	input/output - standard I/O –	Lecture + question answer session.
7.	memory mapped I/O –	Lecture + question answer session.

8.	microcomputer I/O circuits –	Lecture + question answer session.
9.	interrupt driven I/O —	Lecture + question answer session.
10.	DMA, Coprocessors.	Lecture + question answer session.
11.	8085 Microprocessor architecture,	Lecture + question answer session.
12.	8085 Microprocessor architecture,	Lecture + question answer session.
13.	8085 Microprocessor architecture,	Lecture + question answer session.
14.	8085 Microprocessor architecture,	Lecture + question answer session.
15.	addressing modes,	discussion
16.	instruction set, -	Lecture + question answer session.
17.	simple programming concepts	Lecture + question answer session.
18.	Revision	Lecture + question answer session.
19.	The Intel 8086 - architecture –-	Teacher student interactive session
20.	The Intel 8086 - architecture	Lecture + question answer session.
21.	The Intel 8086 - architecture	Lecture + question answer session.
22.	The Intel 8086 - architecture	Lecture + question answer session.
23.	system design	Lecture + question answer session.
24.	system design	Lecture + question answer session.

25.	8086 addressing modes	Lecture + question answer session.
26.	8086 addressing modes	Lecture + question answer session.
27.	CIA -1	Exam
28.	instruction set-	Lecture + question answer session.
29.	instruction format - Programming with 8086 -	Lecture + question answer session.
30.	instruction format - Programming with 8086 -	Lecture + question answer session.
31.	instruction format - Programming with 8086 -	Lecture + question answer session.
32.	interfacing memory and I/O ports -	Lecture + question answer session.
33.	interfacing memory and I/O ports -	Lecture + question answer session.
34.	interfacing memory and I/O ports -	Lecture + question answer session.
35.	Intel 8087.	Lecture + question answer session.
36.	Revision	Lecture + question answer session.
37.	comparison of microprocessors and microcontrollers -	Lecture + question answer session.
38.	The 8051 architecture - -	Lecture + question answer session.
39.	The 8051 architecture - -	Lecture + question answer session.
40.	The 8051 architecture - -	Lecture + question answer session.
41.	The 8051 architecture - -	Lecture + question answer session.
42.	Register set of 8051 -	Lecture + question answer session.

43.	important operational features -	Lecture + question answer session.
44.	I/O pins, ports and circuits -	Lecture + question answer
45.	external memory -	Lecture + question answer session.
46.	counters and timers –	Discussion
47.	interrupts -	Discussion
48.	Instruction set of 8051	Discussion
49.	Instruction set of 8051	Discussion
50.	Basic programming concepts	Lecture + question answer session.
51.	Basic programming concepts -	Lecture + question answer session.
52.	Applications of microcontrollers - (basic ideas) –	Lecture + question answer session.
53.	Embedded systems(basic ideas)	General
54.	Revision	question answer session.
55.	Schottky barrier diode	Lecture + question answer session.
56.	- qualitative characteristics — tunnelling barrier –	Lecture + question answer session.
57.	Hydrogen atom problem - 3	Lecture + question answer session.
58.	CIA - 2	Exam
59.	ideal junction properties –	Lecture + question answer session.
60.	nonlinear effects on barrier height –	Lecture + question answer session.
61.	comparison with junction diode –	Lecture + question answer session.
62.	metal semiconductor ohmic contact –	Lecture + question answer session.

63.	specific contact resistances –	Lecture + question answer session.
64.	ideal non rectifying barriers –	Lecture + question answer session.
65.	hetro-junctions – hetro junction materials –	Lecture + question answer
66.	two dimensional electron gas –	Lecture + question answer session.
67.	energy band diagram –	Lecture + question answer session.
68.	current voltage characteristics	Discussion
69.	Revision	Discussion
70.	Microcomputer hardware system	PPT talk and interaction
71.	– memory organization –	PPT + Demonstration using examples
72.	main memory array –	Lecture + question answer session.

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

Text

1. Microprocessors and Microcomputer based system design, H. Rafiquizzaman, Universal Book stall, New Delhi
2. Microprocessor and Peripherals, S.P. Chowdhury & S. Chowdhury-SCITECH

Publications
3. Microprocessor Architecture Programming and Applications with 8085, R.S. Gaonkar – Penram int. Pub. Mumbai
4. The 8051 microcontroller, Architecture Programming and Applications, Kenneth J Ayala- Penram Int. Pub. Mumbai.
5. Semiconductor Physics and Devices, Donald A. Neamen, McGraw Hill

Reference Books:

A Modern approach to quantum mechanics, John S. Townsend, Viva Books MGH.
Quantum Mechanics, Concepts and Applications, N. Zettily, John Wiley & Sons
Quantum Mechanics, L.I. Schiff, Tata McGraw Hill
5. Numerical Mathematical Analysis, J.B. Scarborough, 4th Edn, 1958

Assignments and Viva

	Nature of assignment and viva	**Marks**
1	Viva + assignments	10
2	Viva + assignments	10
3	Viva + assignments	10
4	Viva + assignments	10
5	Presentation + viva	10

Additional Work:

Reading session in the library: *Library reading and YouTube lectures.*

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	3
COURSE CODE AND TITLE	**P3PHYT12 : INTEGRATED ELECTRONICS AND DIGITAL SIGNAL PROCESSING**	CREDIT	3
Theory HOURS/WEEK	3	HOURS/SEM	54
FACULTY NAME	Dr. SUMOD S G		

Course Objective:

- To understand various process steps involved in IC fabrication
- To understand basics of signal processing and classification of signals
- To understand and apply various signal process to solve problems
- To analyze the difference between FT, DTFT, CTFT, DFT, FFT etc

SESSION	TOPIC	LEARNING RESOURCES
MOULE 1 Integrated Circuit Fabrication and Characteristics		
1	Integrated circuit technology	Lect + PPT
2	**ICT continue**	Lect + PPT
3	basic monolithic IC	Lect + PPT
4	epitaxial growth	Lect + PPT
5	**Epitaxial growth continue**	Lect + PPT
6	marking and etching	Lect + PPT
7	diffusion of impurities	Lect + PPT
8	**Diffusion - continue**	Lect + PPT
9	transistor for monolithic circuit	Lect + PPT
10	monolithic diodes	Lect + PPT
11	**Monolithic diodes - continue**	Lect + PPT
12	integrated resisters, capacitors and inductors	Lect + PPT

13	monolithic circuit layout	Lect + PPT
14	additional isolation methods	Lect + PPT
15	MSI, LSI, VLSI (basic ideas) metal semiconductor contact.	Lect + PPT
16	Revision/test	Lect + PPT
17	Signals and representation	Lect + PPT
18	Classification of signals	Lect + PPT
19	Classification of signals	Lect + PPT
20	Continuous time (CT) and discrete time (DT) signals	Lect + PPT
21	Standard CT and DT signals	Lect + PPT
22	Fourier Analysis of periodic and aperiodic continuous time signals	Lect + PPT
23	Fourier Analysis of periodic and aperiodic continuous time signals	Lect + PPT
24	Convolution and correlation of DT and CT Signals	Lect + PPT
25	Convolution and correlation of DT and CT Signals	Lect + PPT
26	Classification of systems CT – DT	Lect + PPT
27	Classification of systems CT – DT	Lect + PPT
28	Causal, noncausal	Lect + PPT
29	Static and dynamic systems	Lect + PPT
30	Stable systems	Lect + PPT
31	FIR and IIR systems	Lect + PPT
32	FIR and IIR systems	Lect + PPT
33	frequency domain representation of systems	Lect + PPT
34	Frequency domain representation of systems	Lect + PPT

35	Frequency analysis of DT signals	Lect + PPT
36	Frequency analysis of DT signals	Lect + PPT
37	discrete Fourier Transform	Lect + PPT
38	discrete Fourier Transform	Lect + PPT
39	Fast Fourier Transform (FFT)	Lect + PPT
40	Fast Fourier Transform (FFT)	Lect + PPT
41	Fast Fourier Transform (FFT)	Lect + PPT
42	Fast Fourier Transform (FFT)	Lect + PPT
43	Decimation in time and decimation in frequency algorithm	Lect + PPT
44	Decimation in time and decimation in frequency algorithm	Lect + PPT
45	Decimation in time and decimation in frequency algorithm	Lect + PPT
46	Decimation in time and decimation in frequency algorithm	Lect + PPT
47	Z-Transform regional convergence and properties relation to Fourier Transform	Lect + PPT
48	Z-Transform regional convergence and properties relation to Fourier Transform	Lect + PPT
49	Z-Transform regional convergence and properties relation to Fourier Transform	Lect + PPT
50	Poles and Zeros of system function	Lect + PPT
51	Poles and Zeros of system function	Lect + PPT
52	Gibb’s phenomenon	Lect + PPT
53	Problems	Lect
54	Revision	Lect

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

Text Books

1. Integrated Electronics – Analog and Digital Circuits and Systems, J. Millmann& C.C. Halkias, TMGH
2. Digital Signal Processing: Theor, Analysis and Digital-Filter Design, B. Somanathan Nair, PHI (2004)
3. Digital Signal Processing, P. Ramesh Babu, Scitech
4. Digital Signal Processing, Alan V. Oppenheim & R.W. Schafer, PHI

Reference Books:

1. Computer applications in physics, Suresh Chandra, Alpha Science International (2006)
2. Digital Signal Processing, S. Salivahanan, A. Vallavaraj, C. Gnanapriya, TMH
3. Signals and Systems, Allan V. Oppenheim, Alan S. Willsky, S.H. Nawab, PHI
4. Digital Signal Processing, John G. Proakis, Dimitris G. Manolakis, PHI
5. Digital signal processing, Sanjay Sharma, S.K. Kataria& Sons, 2010
6. Mathematical Methods for Physicists, G.B. Arfken& H.J. Weber.Elsavier, Academic Press