ST. THOMAS' COLLEGE (AUTONOMOUS)
THRISSUR, KERALA – 680001

Affiliated to University of Calicut
Nationally reaccredited with 'A' Grade

CURRICULUM AND SYLLABUS
FOR
POSTGRADUATE PROGRAMME IN PHYSICS

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM
(w.e.f. 2020 Admission onwards)

ST. THOMAS COLLEGE (AUTONOMOUS), THRISSUR

OUTCOME BASED EDUCATION

POST GRADUATE PROGRAM OUTCOMES

At the end of Post Graduate Program at St. Thomas College (Autonomous), a student would have:

PO1:	Attained profound **Expertise in Discipline**.
PO2:	Acquired **Ability to function in multidisciplinary Domains**.
PO3:	Attained ability to exercise **Research Intelligence** in investigations and Innovations.
PO4:	Learnt Ethical Principles and be committed to **Professional Ethics**.
PO5:	Incorporated **Self-directed and Life-long Learning**.
PO6:	Obtained Ability to maneuver in diverse contexts with **Global Perspective**.
PO7:	Attained **Maturity to respond to one’s calling**.

PROGRAMME: M.Sc. PHYSICS

Programme Specific Outcomes

PSO	Outcomes
PSO1	Understand the advanced concepts of Classical Mechanics Electrodynamics, Solid State Physics and Spectroscopy.
PSO2	Recognize the significance of mathematical modelling, computation simulation technique and acquire ability to solve problems using mathematical methods.
PSO3	Acquire systematic understanding of the theoretical basis of topics Quantum Mechanics, Statistical Mechanics, Nuclear and Particle Physics.
PSO4	Understand and apply the various concepts of Electronics, Microprocessors,Microcontrollers, Experimental Techniques, Laser Systems and Optical Fibres.
PSO5	Apply and verify theoretical concepts through laboratory experiments. Understand the current research activities.

Abbreviations used:

CL - Cognitive level
R Remember
U - Understand
Ap - Apply
An - Analyze
E……….Evaluate
C - Create
KC - Knowledge category
C - Conceptual
F - Factual
P - Procedural
M - Metacognitive

St. Thomas' College (Autonomous), Thrissur

Scheme and Syllabus for
M. Sc. (Physics) Programme (CBCSS-PG-2020)
(w.e.f. **2020** admission)

The duration of the M.Sc. (Physics) programme shall be 2 years, split into 4 semesters. Each course in a semester has 4 credits (4C) with practicals having 3 credits (3C). The total credits for the entire programme (Core & Elective) is 80. The credit for audit courses is 8. The scheme and syllabus of the programme, consisting of sections *(a) Programme structure (b) Courses and credit distribution summary (c) Courses in various semesters (d) Constitution of clusters (e) The credits and hours (f) Evaluation and Grading (g) Internal evaluation/continuous assessment (h) Pattern of question papers and (i) Detailed syllabus are as follows.*

a) PROGRAMME STRUCTURE

1. The programme shall include three types of courses: **Core courses**, **Elective courses and Audit Courses**.
2. Comprehensive Viva-voce and Project Work / Dissertation shall be treated as Core Courses and these shall be done in the final semester.
3. Total credit for the programme shall be 80 (eighty), this describes the weightage of the course concerned and the pattern of distribution is as detailed below:
   i. Total Credit for Core Courses (both theory &practical's) shall be 60 (sixty).
   ii. Total Credit for Elective Course shall be 12 (twelve).
   iii. Total Credits for Comprehensive Viva-voce and Project Work combined together shall be 8 (eight) subject to a minimum of 4 (four) credit for Project Work
4. **Audit Courses:** In addition to the above courses there will be two Audit Courses ***(AbilityEnhancement Course & Professional Competency Course)*** with **4** credits each. These have to be done one each in the first two semesters. The credits will not be counted for evaluating the overall SGPA & CGPA. Students have to obtain only minimum pass requirements in the Audit Courses. The details of Audit courses are given below.

Semester	Course Title	Suggested Area	Details
I	Ability Enhancement Course (AEC)	Internship / Seminar presentation / Publications / Industrial or Practical Training /Community linkage programme / Book reviews etc.	Seminar: Each student has to present a seminar on a selected topic in physics. A report has to be prepared and submitted before presenting the seminar. The abstract of the seminar has to be sent to the head of the department through the teacher in charge. Or It can be a course related to any topic from the suggested areas.
II	Professional Competency Course (PCC)	To test the skill level of students like testing the application level of different softwares such as Latex/Data visualization/ Python/Any software relevant to the programme of study /Translations etc.	The students in their second semester will be trained on the use of Latex scientific document preparation system. (The syllabus will be part of the second semester). The latex codes for preparing the following items will be developed. 1. A question paper 2. A review paper on a topic related to the seminar given in the first semester 3. A power point presentation Evaluation of this will be based on a multiple choice written examination and an internal practical exam. Or It can be a course related to any topic from the suggested areas.

b) COURSES AND CREDIT DISTRIBUTION SUMMARY:

Semester	Courses	*Teaching Hours*	*Credit*	*Total Credit*
I	Core Courses (Theory/Practical)	*Teaching hours can be fixed by the concerned BoS for various courses and shall not exceed 25 hours per week @ 5 hours per day.*	*For Core course total credit can vary from 60 to68. For Elective Course total Credit can vary from 12 to20 Minimum Credit for one course shall not be less than 2 (two) and shall not exceed 5 (five).* *The maximum credit for comprehensive Viva-voce and Project Work combined together shall be 8 (eight) subject to a minimum credit of 4 (four) for Project Work.*	*Vary from 18 to 22 in each Semester* (For M.sc Physics programme, since conducting practical examination in each semester is not viable, practical exams will be conducted in even semesters. Hence the total credits for the various semesters are as given under : Sem I:16 Sem II:22 Sem III:16 Sem IV:26
II	Core Courses (Theory/Practical)			
III	(I)Core Courses Theory/Practical) (ii) Elective Courses(Theory/Practical)			
IV	(i) Core Courses (Theory /Practical) Including: (a) Comprehensive Viva-voce (Optional) Project Work/ dissertation (ii) Elective Courses (Theory/Practical)			
			Total credit shall be	***80***

I	***Audit Course I :*** *Ability Enhancement Course(AEC)*	*Not coming in the normal work load*	*4 (Not added for SGPA / CGPA)*	*4*
II	***Audit Course II :*** *Professional Competency Course (PCC)*		*4 (Not added for SGPA / CGPA)*	*4*

c) COURSES IN VARIOUS SEMESTERS

Semester – I (16C)	(PHY1C01)	Classical Mechanics	4C
	(PHY1C02)	Mathematical Physics – I	4C
	(PHY1C03)	Electrodynamics and Plasma Physics	4C
	(PHY1C04)	Electronics	4C
	(PHY1L01)	General Physics Practical -I *	
	(PHY1L02)	Electronics Practical – I**	
	(PHY1A01)	Ability Enhancement Course	4C
Semester – II (22C)	(PHY2C05)	Quantum Mechanics –I	4C
	(PHY2C06)	Mathematical Physics – II	4C
	(PHY2C07)	Statistical Mechanics	4C
	(PHY2C08)	Computational Physics	4C
	(PHY2L03)	General Physics Practical - II *	3C
	(PHY2L04)	Electronics Practical – II **	3C
	(PHY2A02)	Professional Competency Course	4C
Semester – III (16C)	(PHY3C09)	Quantum Mechanics - II	4C
	(PHY3C10)	Nuclear and Particle Physics	4C
	(PHY3C11)	Solid State Physics	4C
	(PHY3E05)	Experimental Techniques	4C
		Project #	
	(PHY3L05)	Modern Physics Practical – I ##	
Semester – IV (26C)	(PHY4C12)	Atomic and Molecular Spectroscopy	4C
	(PHY4E13)	Laser Systems, Optical Fibres and Applications	4C
	(PHY4E20)	Microprocessors, Microcontrollers and Applications	4C
	(PHY4P01)	Project #	4C
	(PHY4L06)	Modern Physics Practical –II ##	3C
	(PHY4L07)	Computational Physics Practical	3C
		Viva Voce (Comprehensive)	4C

* *External Practical Exam for PHY1L01&PHY2L03 together will be conducted at the end of 2nd semester.*

** *External Practical Exam for PHY1L02&PHY2L04 together will be conducted at the end of 2nd semester*

\# *Project will be started at 3rd semester and external evaluation for PHY4P01 will be conducted at the end of 4th semester.*

\## *External Practical Exam for PHY3L05 & PHY4L06 together will be conducted at the end of 4th semester*

d) CONSTITUTION OF CLUSTERS

Elective -I Cluster:

(PHY3E01) Plasma Physics
(PHY3E02) Advanced Quantum Mechanics
(PHY3E03) Radiation Physics
(PHY3E04) Digital Signal Processing
(PHY3E05) Experimental Techniques
(PHY3E06) Elementary Astrophysics

Elective -II Cluster:

(PHY4E07) Advanced Nuclear Physics
(PHY4E08) Advanced Astrophysics
(PHY4E09) Astrophysics and Astronomical Data Analysis
(PHY4E10) Advanced Statistical Mechanics
(PHY4E11) Materials Science
(PHY4E12) Electronic Instrumentation
(PHY4E13) Laser Systems, Optical Fibres and Applications
(PHY4E14) Communication Electronics

Elective -III Cluster:

(PHY4E15) Quantum Field Theory
(PHY4E16) Chaos and Nonlinear Physics
(PHY4E17) Advanced Condensed Matter Physics
(PHY4E18) Modern Optics
(PHY4E19) Physics of Semiconductors
(PHY4E20) Microprocessors, Microcontrollers and Applications

e) THE CREDITS AND HOURS PER WEEK

The credits and hours proposed for various courses in different semesters are as given under.

Semester	No. of Theory Papers	Practicals	Theory		Practical		Project		Seminar/Tutorial	Viva Cred.	Total hours	Total Cred
			Hrs	Cred	Hrs	Cred	Hrs	Cred	Hrs			
I	4	1. Gen. Phys I 2. Electronics I	16	16	8	0	0	0	1	0	25	16
II	4	1. Gen. Phys II 2. Electronics II	16	16	8	6	0	0	1	0	25	22
III	4	1. Mod. Phys I	16	16	4	0	4	0	1	0	25	16
IV	3	1. Mod Phys II 2. Comp. Phys	12	12	8	6	4	4	1	4	25	26
Total Credits for the Programme												**80**

f) EVALUATION AND GRADING

1. **Evaluation**: The evaluation scheme for each course shall contain two parts; (a) Internal /Continuous Assessment (CA) and (b) External / End Semester Evaluation (ESE). Of the total, 20% weightage shall be given to internal evaluation / Continuous assessment and the remaining 80% to External/ESE and the ratio and weightage between Internal and External is **1:4. Both the internal and External evaluation shall be carried out using direct grading system as per the general guidelines of university and regulation of St.Thomas College (Autonomous).**

    i. Accumulated minimum credit required for successful completion of the course shall be 80.

    ii. A project work of 4 credits is compulsory and it should be done in III & IV semesters. Also a comprehensive Viva Voce may be conducted by external examiners at the end of IV Semester and carries 4 credits.

    iii. Evaluation and Grading \The evaluation scheme for each course shall contain two parts;

    (a) Internal / Continuous Assessment (CA) and **(b)** External / End Semester Evaluation

(ESE). Of the total, 20% weightage shall be given to Internal evaluation / Continuous assessment and the remaining 80% to External/ESE and the ratio and weightage between Internal and External is **1:4.**

iv. Primary evaluation for Internal and External shall be based on 6 letter grades **(A+, A, B, C, D and E)** with numerical values (Grade Points) of **5, 4, 3, 2, 1 & 0** respectively.

Grade	Grade Points
A+	5
A	4
B	3
C	2
D	1
E	0

2. **Grade Point Average:** Internal and External components are separately graded and the combined grade point with weightage **1** for Internal and **4** for external shall be applied to calculate the **Grade Point Average (GPA)** of each course. Letter grade shall be assigned to each course based on the categorization based on **Ten point Scale** shown below.

The Grade Range for External shall be:

Letter Grade	Grade Range	Range of Percentage(%)	Merit /Indicator
O	4.25 – 5.00	85.00 – 100.00	Outstanding
A+	3.75 – 4.24	75.00 – 84.99	Excellent
A	3.25 – 3.74	65.00 – 74.99	Very Good
B+	2.75 – 3.24	55.00 – 64.99	Good
B	2.50 – 2.74	50.00 – 54.99	Above Average
C	2.25 – 2.49	45.00 – 49.99	Average
P	2.00 -2.24	40.00 – 44.99	Pass
F	< 2.00	Below 40	Fail
I	0	-	Incomplete
Ab	0	-	Absent

No separate minimum is required for internal evaluation for a pass, but a minimum **P** Grade is required for a pass in the external evaluation. However, a minimum **P grade** is required for pass in a course. A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch.

3. Semester Grade Point Average (SGPA)

The **SGPA** is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses taken by a student. After the successful completion of a semester, **S**emester **G**rade **P**oint **A**verage **(SGPA)** of a student in that semester is calculated using the formula given below.

Semester Grade Point Average - SGPA (S_j) = Σ (C_i x G_i) / Cr (SGPA= Total Credit Points awarded in a semester / Total credits of the semester)

where **'S_j'** is the **jth** semester , '**G_i**' is the grade point scored by the student in the **ith** course '**c_i** ' is the credit of the **ith**course,'**Cr** ' is the total credits of the semester .

4. Cumulative Grade Point Average (CGPA)

Cumulative Grade Point Average (CGPA) = Σ(C_i x S_i) / Cr (CGPA= Total Credit points awarded in all semesters/Total credits of the programme)

where C_1 is the credit of the Istsemester **S_1** is the **SGPA** of the **Ist** semester and **Cr** is the total number of credits in the programme. The **CGPA** is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme. The **SGPA** and **CGPA** shall be rounded off to 2 decimal points.

For the successful completion of a semester, a student should pass all courses and score a minimum **SGPA** of 2.0. However, the students are permitted to move to the next semester irrespective of their **SGPA.**

5. Evaluation of Audit Courses:

The examination and evaluation shall be conducted by the college itself either in the normal structure or MCQ model from the Question Bank and other guidelines. The Question paper shall be for minimum 20 weightage and a minimum of 2 hour duration for the examination. The result has to be intimated / uploaded to the Controller of Examinations during the Third Semester as per the notification.

g) INTERNAL EVALUATION / CONTINUOUS ASSESSMENT (CA)

This assessment shall be based on a predetermined transparent system involving periodic written tests, assignments, seminars and viva-voce in respect of theory courses and based on tests, lab skill and records/viva in respect of practical courses. The criteria and percentage of weightage assigned to various components for internal evaluation are as follows

Theory :			
Sl.No	**Component**	**Percentage**	**Weightage**
1	Average of two examinations	40%	2
2	Seminars / Presentation	20%	1
3	Assignment	20%	1
4	Attendance	20%	1
Practical :			
1	Lab Skill	40%	4
2	Records/viva	30%	3
3	Practical Test	30%	3

Grades given for the internal evaluation are based on the grades A+, A, B, C, D& E with grade points 5, 4, 3, 2, 1 & 0 respectively. The overall grades shall be as per the Ten Point scale. There shall be no separate minimum Grade Point for internal evaluation.

Internal Examination

The average of the two examinations/tests can be used to obtain the letter grades as per the following table

Average %/grade range of 2 tests	**Grade**	**Grade point**
90 - 100% ….**(4.5 to 5)**	A+	**5**
75 – 89.99%...**(3.75-4.49)**	**A**	**4**
60 – 74.99%...**(3.0 to 3.74)**	**B**	**3**
40 – 59.99%...**(2 to 2.99)**	**C**	**2**
Below 40% **(Below 2.0)**	**D**	**1**
Absent	**E**	**0**

Attendance

Letter grades of attendance can be derived as per the following table

Range of attendance	**Grading**	**Grade point**
>=90%	**A+**	**5**
85% >=Attendance<90%	**A**	**4**
80% >=Attendance<85%	**B**	**3**
75% >=Attendance<80%	**C**	**2**
50% >=Attendance<75%	**D**	**1**
<50%	**E**	**0**

Project:

Internal evaluation:

a) Monthly progress - wt = 2
b) Regularity and attendance -wt = 1
c) Seminar and Viva Voce- wt = 1

h) PATTERN OF QUESTION PAPERS

1. Theory: Every semester

Directions for question paper setters:

Part A: Set each questions to be answered in 7.5 minutes duration and should extract the critical knowledge acquired by the candidate in the subject.
Part B: 30 minutes answerable questions each may be asked as a single question or parts. Derivation type questions can be also asked.

Part C: 15 minutes answerable questions each and as far as possible avoid numerical type questions.

Division	*Type*	*No.of Questions*	*Weightage*	*Total Weightage*
Part A	Short Answer	8(No Choice)	1	**8**
Part B	Essay	2 out of 4	5	**10**
Part C	Problems	4 out of 7	3	**12**
Total weightage for a question paper				**30**

Theory papers must contain at least 4 lectures plus 1 Tutorial. Project is equivalent to one theory paper (4 hours) and one practical (4 hours)

Answer to each question may be evaluated based on
(a) Idea/knowledge – wt =1
(b) Logic/steps – wt =1
(c) Analytic skill – wt =1
(d) Correctness – wt =1

2. Practical exam : At the end of II and IV semesters and each will be of 6 hours duration.

3. Project evaluation: At the end of IV semester. Its evaluation is based on:

a) Presentation-wt= 4
b) Project Report (Novelty, Creativity & work)-wt = 8
c) Project viva-wt = 4

Comprehensive Viva-Voce at the end of IV semester.

STUDY TOUR

Minimum two days visit to National research Institutes, Laboratories and places of scientific importance is mandatory. Study tour report has to be submitted with photos and analysis along with PROJECT REPORT for evaluation.

(h) DETAILED SYLLABUS

FIRST SEMESTER				
Course code	PHY1C01			
Name of the course	CLASSICAL MECHANICS (72hrs)			
Course No	Course Category Core/Compli/ Elective	Number of Credits	Number of hours of Lectures/week	Internal – External ratio
01	CORE	4	4	1:4

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the necessity of Lagrangian, and Hamiltonian formalism for solving problems in physics and analyse which of these strategies is most useful for a given problem.	17	U, An	C	1,3	PSO1
CO2	Understand the classical background behind the quantum mechanics and analyse it using canonical transformations and Hamilton – Jacobi method	19	U, An	C	1	PSO1
CO3	Understand and apply the theory of rigid body motion in several areas of physics	14	U, Ap	C, P	3	PSO1
CO4	Understand the theory of small oscillations and apply it to several areas of physics.	9	U, Ap	C, P	3	PSO1
CO5	Describe the classical applications in the field of nonlinear dynamics and chaos	13	U	C	1,3	PSO1

1. Lagrangian and Hamiltonian Formulation:

Constraints and Generalized coordinates, D 'Alembert's principle and Lagrange's equation, Velocity dependent potentials, Simple applications, Hamilton's Principle, Lagrange's equation from Hamilton's principle, Kepler problem, Scattering in a central force field, Transformation to lab coordinates, Legendre Transformation, Hamilton's canonical equations, Principle of least action, Canonical transformations, examples (**17 hours**)

Text : Goldstein, Sections 1.3 – 1.6, 2.1 – 2.3, 3.10, 3.11, 8.1, 8.5, 8.6, 9.1,9.2

2. The classical background of quantum mechanics:

Equations of canonical transformations, Examples, Poisson brackets and other canonical invariants, Equation of motion in Poisson bracket form, Angular momentum Poisson brackets, Hamilton-Jacobi equation, Hamilton's principal and characteristic function, H-J equation for the linear harmonic oscillator, Separation of variables, Action-angle variables, H-J formulation of the Kepler problem, H-J equation and the Schrödinger equation. (**19 hours**)

Text : Goldstein, Sections 9.1, 9.2, 9.4 - 9.6, 10.1 – 10.5, 10.7,10.8

3. The Kinematics and Dynamics of Rigid Bodies:

Space-fixed and body-fixed systems of coordinates, Description of rigid body motion in terms of direction cosines and Euler angles, Infinitesimal rotation, Rate of change of a vector, Centrifugal and Coriolis forces, Moment of inertia tensor, Euler's equation of motion, Force free motion of a rigid bodies. (**14 hours**)

Text : Goldstein, Sections 4.1, 4.4, 4.8 – 4.10

4. Small Oscillations:

Formulation of the problem, Eigen value equation, Eigenvectors and Eigenvalues, Orthogonality, Principal axis transformation, Frequencies of free vibrations, Normal coordinates, Free vibrations of a linear tri atomic molecule.(**9 hours**)

Text : Goldstein, Sections 6.1 – 6.4

5. Nonlinear Equations and Chaos:

Introduction, Singular points of trajectories, Nonlinear oscillations, Limit cycles, Chaos : Logistic map, Definitions, Fixed points, Period doubling, Universality. (**13 hours**)

Text : Bhatia, Sections10.1, 10.2, 10.3, 10.4, 10.5, 10.51

Textbooks:

1. Goldstein "Classical Mechanics" (Addison Wesley)
2. V.B. Bhatia : "Classical Mechanics" (NarosaPublications,1997)

Reference books :

1. Michael Tabor : "Chaos and Integrability in Nonlinear Dynamics" (Wiley, 1989)
2. N.C.Rana and P.S.Joag : "Classical Mechanics" (Tata McGraw Hill)
3. R.G.Takwale and P.S.Puranik : "Introduction to Classical Mechanics" (Tata McGraw Hill)
4. Atam P. Arya : "Introduction to Classical Mechanics, (2nd Edition)" (Addison Wesley1998)

5. Laxmana : "Nonlinear Dynamics" (Springer Verlag, 2001)

For further reference: Classical Physics Video Prof. V. Balakrishnan IIT Madras
http://nptel.iitm.ac.in/video.php?subjectId=122106027
Special Topics in Classical Mechanics Video Prof. P.C. Deshmukh IIT Madras
http://nptel.iitm.ac.in/courses/115106068/
Physics I - Oscillations & Waves Video Prof. S. Bharadwaj IIT Kharagpur
http://nptel.iitm.ac.in/video.php?subjectId=122105023
Chaos, Fractals & Dynamic Systems Video Prof. S. Banerjee IIT Kharagpur
http://nptel.iitm.ac.in/video.php?subjectId=108105054

FIRST SEMESTER				
Course code	**PHY1C02**			
Name of the course	**MATHEMATICAL PHYSICS -1** (72hrs)			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
02	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand and apply the concept of Vector Calculus in different coordinate system	11	**U, Ap**	**C**	**1,2**	**PSO2**
CO2	Understand the aspects of Matrices & Tensor	11	**U**	**C**	**1,2**	**PSO2**
CO3	Understand about Second order differential equations	14	**U**	**C**	**1,2**	**PSO2**
CO4	Understand and analyze different Special functions	24	**U, An**	**C,P**	**1,2**	**PSO2**
CO5	Understand and apply the concepts of Fourier Series, Fourier Transform & Laplace Transform	12	**U, Ap**	**C,P**	**1,2,3**	**PSO2**

1. Vectors:

Rotation of coordinates, Orthogonal curvilinear coordinates, Gradient, Divergence and Curl in orthogonal curvilinear coordinates, Rectangular, cylindrical and spherical polar coordinates, Laplacian operator, Laplace's equation – Vector integration, Enough exercises. (**11 hours**)

Text: Arfken & Weber, Sections 1.2, 1.6 - 1.9, 1.10, 2.1 – 2.5

2. Matrices and Tensors:

Basic properties of matrices (Review only), Orthogonal matrices, Hermitian and Unitary matrices, Similarity and Unitary transformations, Diagonalization of matrices, Definition of Tensors, Contraction, Direct products, quotient rule, Pseudo tensors, Dual tensors, Levi Cevita symbol, Irreducible tensors, Enough exercises. (**11 hours**)

Text: Arfken & Weber, Sections 3.2 - 3.5, 2.6 – 2.9

3. Second Order Differential Equations:

Partial differential equations of Physics, Separation of variables, Singular points, Ordinary series solution, Frobenius method, A second solution, Self adjoint differential equation, Eigen functions and values, Boundary conditions, Hermitian operators and their properties, Schmidt orthogonalization, Completeness of functions, Enough exercises. (**14 hours**)

Text :Arfken & Weber , Sections 8.1, 8.3 – 8.6, 9.1 – 9.4

4. Special functions:

Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions of the first and second kinds, Generating function, Recurrence relation, Orthogonality, Neumann function, Spherical Bessel function, Legendre polynomials, Generating function, Recurrence relation, Rodrigues' formula, Orthogonality, Associated Legendre polynomials, Spherical harmonics, Hermite polynomials, Laguerre polynomials, Enough exercises.**(24 hours)**

Text: Arfken & Weber, Sections 10.1, 10.4, 1.15, 11.1 – 11.3, 11.7, 12.1 – 12.4, 12.6, 13.1, 13.2

5. Fourier Series:

General properties, Advantages, Uses of Fourier series, Properties of Fourier series, Fourier integral, Fourier transform, Properties, Inverse transform, Transform of the derivative, Convolution theorem, Laplace transform, Enough exercises.**(12 hours)**

Text: Arfken & Weber, Sections 14.1 – 14.4, 15.2 – 15.5, 15.8

Text book :

1. G.B.Arfken and H.J.Weber : "Mathematical Methods for Physicists (5th Edition, 2001), (Academic Press)

Reference books :

1. J.Mathews and R.Walker : "Mathematical Methods for Physics" (Benjamin)
2. L.I.Pipes and L.R.Harvill : "Applied Mathematics for Engineers and Physicists (3^{rd} Edition)" (McGraw Hill)
3. Erwin Kreyzig : "Advanced Engineering Mathematics - 8th edition" (Wiley)
4. M. Greenberg : "Advanced Engineering Mathematics – 2nd edition " (Pearson India 2002)
5. A.W. Joshi : Matrices and tensors
6. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons
7. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. DiPrima, John Wiley & Sons, Inc.
8. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York

For further reference:

1. Mathematics I Video Prof. Swagato K. Ray,Prof. ShobhaMadan,Dr. P. Shunmugarajhttp://nptel.iitm.ac.in/video.php?subjectId=122104017
2. Mathematics II Video Prof. SunitaGakkhar, Prof. H.G. Sharma, Dr. TanujaSrivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107036
3. Mathematics III Video Prof. P.N. Agrawal, Dr. TanujaSrivastava IIT Roorkeehttp://nptel.iitm.ac.in/video.php?subjectId=122107037

FIRST SEMESTER				
Course code	PHY1C03			
Name of the course	ELECTRODYNAMICS AND PLASMA PHYSICS (72hrs)			
Course No	Course Category Core/Compli/ Elective	Number of Credits	Number of hours of Lectures/week	Internal – External ratio
03	CORE	4	4	1:4

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understanding the basics of time varying fields and radiations	**14**	**U**	**C, P**	**1**	**PSO1**
CO2	Understanding the propagation of plane electromagnetic waves through different media	**13**	**U, Ap**	**C, P**	**1**	**PSO1**
CO3	Analyze the propagation of electromagnetic waves through a transmission line and wave guides.	**14**	**U, Ap**	**C, P**	**1,3**	**PSO1**
CO4	Understand the concept of relativistic electrodynamics	**15**	**U**	**C**	**1**	**PSO1**
CO5	Understand the plasma physics and antenna fundamentals	**16**	**U**	**C**	**1,3**	**PSO1**

1. **Time varying fields and Maxwell's equations :**

Maxwell's equations (**Self study**), Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Time harmonic fields, Multi-pole expansion of electric scalar potential and magnetic vector potential, Enough exercises. (**14 hours**)
Text : Cheng, Sections 7.3 – 7.7, Griffiths, Sections 3.4, 5.4.2

2. **Plane electromagnetic waves :**

Plane waves in lossless media, Plane waves in lossy media, Group velocity (**Self study**), Flow of electromagnetic power and the Poynting vector, Normal incidence at a plane conducting boundary, Oblique incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary, Oblique incidence at a plane dielectric boundary, Enough exercises. (**13 hours)**

Text : Cheng , Sections 8.2 – 8.10

3. Transmission lines, Wave guides and cavity resonators:

Transverse electromagnetic waves along a parallel plane transmission line, General transmission line equations, Wave characteristics on finite transmission lines, General wave behaviour along uniform guiding structures, Rectangular wave guides, Cavity resonators (Qualitative ideas only), Enough exercises. (**14 hours**)

Text : Cheng, Sections 9.2 - 9.4 , 10.2, 10.4, 10-7.1

4. Relativistic electrodynamics:

Magnetism as a relativistic phenomenon, Transformation of the field, Electric field of a point charge moving uniformly, Electromagnetic field tensor, Electrodynamics in tensor notation, Potential formulation of relativistic electrodynamics, Enough exercises. (**15 hours)**

Text : Griffiths, Sections 10.3.1 – 10.3.5

5. Plasma Physics and Antenna fundamentals :

Plasma - Definition, concepts of plasma parameter, Debye shielding, Motion of charged particles in an electromagnetic field - Uniform electric and magnetic fields, Plasma oscillations, Enough exercises.

Types of antennas, Radiation mechanism, Current distribution on a thin wire antenna, Radiation pattern, Radiation power density, Radiation intensity, Beam width, Directivity, Antenna efficiency, Gain, Beam efficiency, Band width, Input impedance, Antenna radiation efficiency. (**16 hours**)

Text : Chen, Sections 1.1 - 1.6, 2.2 - 2.2.2, 3.1 - 3.3.2, 4.3
Text: Constantine A Balanis, Antenna Theory- Analysis and Design: Sections 1.2, 1.3 (except 1.3.4), 1.4, 2.2– 2.6, 2.8 – 2.11, 2.13, 2.14

Text books :

1. David K. Cheng : " Field and Wave Electromagnetics (Addisson Wesley)
2. David Griffiths : " Introductory Electrodynamics" (Prentice Hall of India, 1989)
3. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Volume I and II, Plenum Press, recent edition
4. Constantine A Balanis, Antenna Theory- Analysis and Design, Wiley, Fourth Edition
5. K.L. Goswami, Introduction to Plasma Physics – Central Book House, Calcutta
6. J.D.Jackson : "Classical Electrodynamics" (3rd Ed.) (Wiley,1999)

FIRST SEMESTER

Course code	PHY1C04			
Name of the course	ELECTRONICS (72hrs)			
Course No	Course Category Core/Compli/ Elective	Number of Credits	Number of hours of Lectures/week	Internal – External ratio
04	CORE	4	4	1:4

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the different types of FET and it's applications and digital MOSFETs	10	U	C, P	1,2	PSO 4
CO2	Understand the construction and working of different type of microwave and photonic devices	14	U	C, P	1,2	PSO 4
CO3	Understand the features of operational amplifier and properties of it	12	U	C	1,2	PSO 4
CO4	Understand the applications of OPAMP and uses of it	14	U	C, P	1,3	PSO 4
CO5	Analyze the digital-electronics and vice versa of counters and flip flop	22	U	C	1,2	PSO 4

1 . **Field effect transistors :**

[**Self-study and assignments** - Basic ideas of FET, Comparison between FET and ordinary transistor, Salient features of FET]

V-I characteristics of JFETs and device operation, construction of depletion and enhancement MOSFETs, V-I characteristics and device operation. Biasing of FETs, FETs as VVR and its applications, small signal model of FETs, analysis of Common Source and Common Drain amplifiers at low and high frequencies, MOSFET as a switch, CMOS and digital MOSFET gates (NOT, NAND, NOR). (**10 hours**)

Text: Integrated Electronics Millman and Halkias: Tata McGraw Hill

Reference:Electronic devices and Circuit theory, Robert L Boylstead& L. Nashelsky – Pearson Education Micro Electronic Circuits: Sedra/Smith: Oxford University Press.

2. Microwave and Photonic devices:

[**Self-study and assignments** - Basic ideas of Tunnel diode, LED and semiconductor LASER, Photo detectors, Light Dependent resistor photodiode and solar cell]

Tunnel diode, construction and characteristics, negative differential resistance and device operation, radiative transitions and optical absorption, Light emitting diodes (LED) – visible and IR, semiconductor lasers, construction and operation, population inversion, carrier and optical confinement, optical cavity and feedback, threshold current density. Photo detectors – Photoconductor (Light dependent resistor- LDR) and photodiode, p-n junction solar cells - short circuit current, fill factor and efficiency (**14 hours**)

Text: Semiconductor Devices- Physics and Technology - S.M.Sze, John Wiley and Sons, Semiconductor Optoelectronic devices: Pallab Bhattacharya: Prentice Hall

Reference:

1. Principles of semiconductor devices: B. Van Zeghbroeck
2. Principles of semiconductor devices: S.M. Sze: John Wiley & Sons

3. Operational Amplifier:

[**Self-study and assignments** - Basic circuit of differential amplifier, common mode and differential mode]

Differential amplifiers, analysis of Emitter coupled differential amplifiers, OPAMP parameters: Open loop gain, CMRR, error currents and error voltages, input and output impedances, slew rate and UGB. Frequency response, poles and zeros; transfer functions (derivation not required), expression for phase angle. Need for compensation, dominant pole, pole zero and lead compensation, step response of an operational amplifier.(**12 hours**)

Text: Integrated Electronics: Millman and Halkias: Tata McGraw Hill

Reference:

OPAMPS and Linear Integrated Circuits: Ramakant A. Gaekwad

4. OPAMP Applications:

[**Self- study** - Multistage OPAMP circuits]

Closed loop inverting, non-inverting and difference OPAMP configurations and theircharacteristics; OPAMP as inverter, scale changer, summer, V to I converter, I to V converter,practical integrator & differentiator, active low pass , high pass and band pass Butterworth filters, band pass filter with multiple feedback, OPAMP notch filter, OPAMP Wien bridge oscillator, OPAMP astable and monostablemultivibrators, Schmidt triggers.(**14 hours**)

Text: **Integrated Electronics: Millman and Halkias: Tata McGraw Hill**
OPAMPS and Linear Integrated Circuits: Ramakant A. Gaekwad

Reference:

Linear Integrated circuits: D. Roychoudhuri: New Age International Publishers.

5. Digital Electronics:

[**Self-study** - Different types of number system, OR ,AND, NOT gates Realization through diode and Transistors, Advantages and disadvantages of digital electronics]

Minimization of Boolean functions using Karnaugh map and representation using logic gates, JK andMSJK andD flip-flops, shift registers using D and JK flip flops and their operations, shift registers as counters, ring counter, design of synchronous and asynchronous counters, state diagram,cascade counters, basic idea of static and dynamic RAM, basics of charge coupled devices. R-2R ladder D/A converter, Introduction to 8 bitmicroprocessor; internal architecture of Intel 8085, register organization.(**22 hours**)

Text:

Digital Principles and Applications: Malvino and Leach: Tata McGraw Hill
Digital Fundamentals: Thomas. L. Floyd: Pearson Education.
Fundamentals of Microprocessors and Microcomputers: B. Ram: DhanpathiRai& Sons.

Reference:

Modern Digital Electronics: R.P. Jain: Tata McGraw Hill
For further reference: Electronics Video Prof. D.C. Dube IIT Delhi,
http://nptel.iitm.ac.in/courses/115102014/
Digital Integrated Circuits Video Prof. AmitavaDasgupta IIT Madras
http://nptel.iitm.ac.in/video.php?subjectId=108106069

FIRST SEMESTER				
Course code	PHY1A01			
Name of the course	ABILITY ENHANCEMENT COURSE (AEC)			
Course No	Course Category Core/Compli/ Elective	Number of Credits	Number of hours of Lectures/week	Total marks (Int+Ext)
05	-	4	-	-

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Analyze the current research programmes in various fields of physics	-	U	C, P	2,3,5	PSO 5
CO2	Understand the idea of writing seminar reports	-	U, Ap	F, P	5	PSO 5
CO3	Understand how to present a seminar	-	U, Ap	F, P	5	PSO 5

Each student has to prepare and present a seminar on recent trends in a selected topic in physics. A report has to be prepared and submitted before presenting the seminar. The abstract of the seminar has to be sent to the head of the department through the teacher in charge.

SECOND SEMESTER				
Course code	**PHY2C05**			
Name of the course	**QUANTUM MECHANICS – I** (72hrs)			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
06	**CORE**	**4**	**4**	**1:4**

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understanding the fundamental mathematical aspects, formulation and development of quantum mechanics	**20**	**U**	**C**	**1, 2**	**PSO 3**
CO2	Understanding the dynamical aspects of quantum mechanics	**20**	**U, An**	**F**	**1**	**PSO 3**
CO3	Understanding the development of angular momentum and how it is suitable for various applications	**15**	**U, An**	**C**	**1, 3**	**PSO 3**
CO4	Applied the knowledge about potential into various environments	**5**	**Ap**	**C**	**1, 3**	**PSO 3**
CO5	Understanding how Invariance Principles and Conservation Laws are influencing operators and wave functions	**12**	**U**	**C**	**1, 2, 3**	**PSO 3**

1. Formulation of Quantum Mechanics :

Sequential Stern-Gerlach experiments – Analogy with the polarization of light – Need for representing a quantum mechanical state as a vector in complex vector space. Dirac notation – Ket space, Bra space and Inner products – Operators– Hermitian adjoint – Hermitian operator – Multiplication – Associative axiom. Eigen kets and eigenvalues of

Hermitian operator – Eigen kets as base kets – Completeness relation – Projection operator – Matrix representation of operators, kets and bras. Measurement in a quantum mechanical system – Expectation value –Illustration with spin-1/2 systems – Compatible observables and simultaneous eigen kets – Maximal set of commuting observables – Incompatible observables and general uncertainty relation. Unitary operator – Change of basis and transformation matrix – Similarity transformation – Diagonalization – Unitary equivalent observables. Position eigen kets and position measurements – Infinitesimal translation operator and its properties – Linear momentum as a generator of translation – Canonical commutation relations. Position-space wavefunction – Momentum operator in the position basis – Momentum-space wavefunction – Transformation function or the momentum eigenfunction in position basis –Relations between wavefunctions in position-space and momentum-space. Gaussian wave packet – Computation of dispersions of position operator and momentum operator – Minimum uncertainty product. Generalization to three dimensions.

Text: **Chapter 1, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai**
Chapter 2 relevant sections, Quantum Mechanics (Edn.4) by V. K. Thankappan

2. Quantum Dynamics

Time-evolution operator – Schrodinger equation for the time-evolution operator and its solutions according to the time-dependence of the Hamiltonian operator –Energy eigenkets – Time dependence of expectation values – Time evolution of a spin-1/2 system and Spin precession – Correlation amplitude and energy-time uncertainty relation. Schrodinger picture and Heisenberg picture – Behaviour of state kets and observables in Schrodinger picture and Heisenberg picture – Heisenberg equation of motion – Ehrenfest's theorem. Time-evolution of base kets and transition amplitudes. Simple harmonic oscillator –creation and annihilation operator- energy eigenkets and energy eigenvalues – Time development of the oscillator. Schrodinger's wave equation – Time-dependent wave equation – Time-independent wave equation – Interpretations of the wavefunction – Classical limit of wave mechanics. Elementary solutions to Schrodinger's wave equation – Free particle in one dimension and three dimensions – Simple harmonic oscillator – Particle in a one-dimensional box – Particle in a finite potential well – One-dimensional potential step – Square potential barrier. **(20 hours)**

Text :(1) Chapter 2 – up to section 2.5, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai
(2) Chapter 4 – section 4.3, Quantum Mechanics (Edn.4) by V. K. Thankappan

3. Theory of Angular Momentum

Finite versus Infinitesimal Rotations– Infinitesimal rotations in quantum mechanics – Fundamental commutation relations for angular momentum operators. Rotation operators for spin-1/2 systems– Spin precession in a magnetic field – Pauli's two component formalism – Representation of the rotation operator as 2 x 2 matrix. Ladder operators and their commutation relations – Eigen value problem for angular momentum operators J^2 and J_z –Matrix elements of angular momentum operators and rotation operator. Orbital angular momentum – Orbital angular momentum as generator of rotation – Spherical harmonics – Spherical harmonics as rotation matrices. Addition of orbital angular momentum and spin angular momentum – Addition of angular momenta of two spin-1/2 particles – Formal theory of Angular Momentum addition – Computation of Clebsch-Gordan coefficients – Clebsch-Gordan coefficients and the rotation matrices.**(15 hours)**

Text :**Chapter 3 – sections 3.1, 3.2, 3.5, 3.6 and 3.8, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai**

4. Central Potentials :

Schrodinger's equation for central potentials – The radial equation –Free Particle in an infinite spherical well – Isotropic harmonic oscillator – The Coulomb potential and the hydrogen atom problem.(**5 hours)**

Text : **Chapter 3 – section 3.7, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai.**

5. Invariance Principles and Conservation Laws

Symmetry and conservation laws –Space-time symmetries – Displacement in space and conservation of linear momentum – Displacement in time and conservation of energy – Rotation in space and conservation of angular momentum – Space inversion and conservation of parity – Time reversal symmetry. The indistinguishability principle – Symmetric and antisymmetric wavefunctions – Eigenvalues and eigenvectors of particle-exchange operator – Spin and statistics – Pauli's exclusion principle and antisymmetric wavefunction – The ground state of Helium atom.(**12 hours**)

Text: Chapter 6 and 9 – relevant sections, Quantum Mechanics (Edn.4) by V. K. Thankappan

Textbooks :

1. Modern Quantum Mechanics (Edn.2) : J. J. Sakurai, Pearson Education.
2. Quantum Mechanics (Edn.4) : V. K. Thankappan, New Age International

References:

1. Principles of Quantum Mechanics (Edn.2) : R. Shankar, Springer.
2. Introductory Quantum Mechanics: Richard L. Liboff, Pearson Education .
3. Introduction to Quantum Mechanics (Edn.2) : D.J. Griffiths, Pearson Education.
4. A Modern Approach to Quantum Mechanics: J S Townsend, Viva Books.

5. Quantum Mechanics : Non-Relativistic Theory (Course of Theoretical Physics Vol3): L. D. Landau and E. M. Lifshitz, Pergamon Press.
6. The Feynman Lectures on Physics Vol. 3, Narosa .
7. Quantum Mechanics : Concepts and Applications (Edn.2) : NouredineZettili, Wiley.
8. Quantum Mechanics Demystified: David McMohan, McGrawHill 2006.
9. Quantum Mechanics (Schaum's Outline) :YoavPeleg*etal*. Tata McGraw Hill Private Limited, 2/e.
10. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
11. www.nptel/videos.in/2012/11/quantum-physics.html
12. https://nptel.ac.in/courses/115106066/

SECOND SEMESTER				
Course code	**PHY2C06**			
Name of the course	**MATHEMATICAL PHYSICS - II** (72hrs)			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
07	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the basic elements of complex mathematical analysis, including the integral theorems and apply it to obtain the residues of a complex function and use this basic concepts of complex functionsto evaluate definite integrals	**15**	**U, Ap**	**C**	**1,2**	**PSO 2**
CO2	Understand the applications of group theory in all the branches of Physics problems.	**20**	**U, Ap**	**C**	**1,2**	**PSO 2**
CO3	Understand and apply the calculus of variables method to solve problems in several areas of physics	**14**	**U, Ap**	**C**	**1,2**	**PSO 2**
CO4	Understand and analyze the basic concepts of integral equations and how to solve mathematical problems involving integral equations of interest in Physics.	**12**	**U, An**	**C**	**1,2**	**PSO 2**
CO5	Understand the applications of Green Functions	**9**	**U, Ap**	**C**	**1,2,3**	**PSO 2**

1. **Functions of Complex Variables:**

[**Self study and assignments**– Brief revision of complex numbers and their Graphical representation , Euler's Formula, De Moivre's theorem, Roots of complex numbers, Functions of complex variables, Taylor's expansion]

Introduction, Analyticity, Cauchy-Reimann conditions, Examples of analytic funcions, Cauchy's integral theorem and integral formula, simply and multiply connected region, Cauchy inequality, Liouville's theorem, Laurent expansion, Singularities, Calculus of residues and applications in solving definite integrals **(15 hours)**

Text: Sections 6.1 to 6.5, 7.1, 7.2Arfken 5th edition

2. **Group Theory:**

[Self-study – Hilbert space, concept of a matrix representing an operator in a Hibert space]

Groups, multiplication table, conjugate elements and classes, subgroups, direct product groups, isomorphism and homomorphism, permutation groups, distinct groups of given order, reducible and irreducible representations.

Text :Sections 1-1.8, 3.1-3.2 Joshi.

Generators of continuous groups, rotation groups SO(2) and SO(3), rotation of functions and angular momentum, SU(2)-SO(3) homomorphism, SU(2) isospin and SU(3) eight fold way (**20 hours**)

Text : Sections 4.2, Arfken 5th edition.

3. **Calculus of Variations:**

One dependent and one independent variable, Applications of the Euler equation, Generalization to several independent variables, Several dependent and independent variables, Lagrange Multipliers, Variation subject to constraints, Rayleigh-Ritz variational technique. (**14 hours)**

Text :Sections 17.1 to 17.8Arfken 5th edition.

4. **Integral equations:**

Integral equations- introduction, Integral transforms and generating functions, Neumann series, separable kernel (**12 hours**)

Text :Sections 16.1 to 16.3Arfken 5th edition.

5. **Green's function:**

Green's function, eigenfunction expansion, 1-dimensional Green's function, Green's function integral-differential equation, eigenfunction, eigenvalue equation Green's function and Dirac delta function, Enough exercises.(**11 hours**)

Text :Section 9.51Arfken 5th edition.

Text books :

1. G.B.Arfken and H.J.Weber : "Mathematical Methods for Physicists (5th Edition, 2001)" (Academic Press)

2. A.W.Joshi, Elements of Group theory for Physicists()(New Age International (P).Ltd)

Reference books :

1. J.Mathews and R.Walker : “Mathematical Methods for Physics” (Benjamin)
2. L.I.Pipes and L.R.Harvill : “Applied Mathematics for Engineers and Physicists (3rd Edition)" (McGraw Hill)
3. Erwin Kreyzig : "Advanced Engineering Mathematics - 8th edition" (Wiley)
4. M. Greenberg : "Advanced Engineering Mathematics – 2nd edition " (Pearson India 2002)
5. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons
6. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. DiPrima, John Wiley & Sons, Inc.
7. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York
8. Group theory and quantum mechanics, Michael Tinkham, Dover Publications, Inc., New York

For further reference:

Mathematics I Video Prof. Swagato K. Ray,Prof. ShobhaMadan,Dr. P. Shunmugaraj
http://nptel.iitm.ac.in/video.php?subjectId=122104017
Mathematics II Video Prof. SunitaGakkhar, Prof. H.G. Sharma, Dr. TanujaSrivastava IIT Roorkee
http://nptel.iitm.ac.in/video.php?subjectId=122107036
Mathematics III Video Prof. P.N. Agrawal, Dr. TanujaSrivastava IIT Roorkee
http://nptel.iitm.ac.in/video.php?subjectId=122107037

SECOND SEMESTER				
Course code	**PHY2C07**			
Name of the course	**STATISTICAL MECHANICS** (72hrs)			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
08	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understanding the statistical basics of thermodynamics	**13**	**U**	**C**	**1,2**	**PSO 3**
CO2	Analyze the three ensembles of statistical mechanics	**21**	**U, An**	**C, P**	**1**	**PSO 3**
CO3	Understanding the formulation of quantum statistics	**15**	**U**	**C**	**1,3**	**PSO 3**
CO4	Apply the quantum statics to Ideal Bose systems	**10**	**U**	**C**	**1,3**	**PSO 3**
CO5	Apply the quantum statics to Ideal Fermi systems and understand the Ising model	**13**	**U**	**C**	**1,3**	**PSO 3**

1. The Statistical Basis of Thermodynamics:

The macroscopic and the microscopic states – Contact between statistics and Thermodynamics: Expressing T, P and μ in terms of – The classical Ideal gas - The entropy of mixing and the Gibbs paradox - Phase space of a classical system - Liouville‟s theorem and its consequences. **(13 Hours)**

Text :Pathria, Sections 1.1 – 1.6, 2.1,2.2

2. Microcanonical, Canonical and Grand Canonical Ensembles:

The microcanonical ensemble – Examples : (1) Classical Ideal gas, (2) Linear harmonic oscillator - Quantum states and the phase space – Equilibrium between a system and a heat reservoir- Physical significance of the various statistical quantities in the canonical ensemble- Alternative expressions for the partition function- Examples: (1) The classical systems: Ideal gas, (2) A system of harmonic oscillators, (3) The statistics of paramagnetism - Energy fluctuations in the canonical ensemble -Equipartition theorem -

Virial theorem - Equilibrium between a system and a particle-energy reservoir- Physical significance of the various statistical quantities in the grand canonical ensemble-Example : Classical Ideal gas - Density and energy fluctuations in the grand canonical ensemble. (**21 Hours**)

Text :Pathria, Sections 2.3 -2.5, 3.1, 3.3 - 3.9, 4.1, 4.3 –4.5

3. **Formulation of Quantum Statistics:**

Quantum-mechanical ensemble theory: The density matrix- Statistics of the various ensembles-Example: An electron in a magnetic field - Systems composed of indistinguishable particles- An ideal gas in a quantum-mechanical microcanonical ensemble- An ideal gas in other quantum-mechanical ensembles-Statistics of the occupation numbers (**15 Hours**)

Text :Pathria, Sections 5.1 - 5.4, 6.1 – 6.3

4. **Ideal Bose Systems:**

Thermodynamic behaviour of an ideal Bose gas- Thermodynamics of the blackbody radiation- The field of sound waves. (**10 Hours**)

Text :Pathria, Sections : 7.1 - 7.3

5. **Ideal Fermi Systems:**

Thermodynamic behaviour of an ideal Fermi gas- Magnetic behaviour of an ideal Fermi Gas : (1) Pauli paramagnetism, (2) Landau diamagnetism – The electron gas in metals (Discussion of heat capacity only), Enough exercises. **Ising Model**: A dynamical model of phase transistions (**13 Hours)**

Text :Pathria, Sections : 8.1 – 8.3, 12.3

Textbook: 1: Statistical Mechanics (2nd Edition), R. K. Pathria , Butterworth Heinemann /Elsevier(1996)

Reference books:

1. Statistical Mechanics : An Elementary Outline, AvijitLahiri, Universities Press (2008)
2. An Introductory Course of Statistical Mechanics, Palash. B. Pal, Narosa (2008)
3. Statistical Mechanics : An Introduction, Evelyn Guha, Narosa (2008)
4. Statistical and Thermal Physics : An Introduction, S. Lokanathan and R.S.Gambhir, Prentice Hall of India (2000).
5. Introductory Statistical Mechanics (2nd Edition), Roger Bowley and Mariana Sanchez, Oxford University Press (2007)
6. Concepts in Thermal Physics, Stephen. J. Blundell and Katherine. M. Blundell, Oxford University Press (2008)
7. An Introduction to Thermal Physics, Daniel. V. Schroeder, Pearson (2006)
8. Statistical Mechanics, Donald. A. McQuarrie, Viva Books (2005)
9. Problems and Solutions on Thermodynamics and Statistical Mechanics, Ed. by Yung – Kuo Lim, Sarat Book House (2001)

For further reference:

Basic Thermodynamics Video Prof. S.K. Som IIT Kharagpur

http://nptel.iitm.ac.in/video.php?subjectId=112105123

SECOND SEMESTER				
Course code	**PHY2C08**			
Name of the course	**COMPUTATIONAL PHYSICS**			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
09	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Develop proficiency to write programs using repetitive control structures, selection statements, built in objects, especially the object-oriented concepts of Python and the usage of data structures like lists, dictionaries.	**12**	**U**	**C**	**1,3**	**PSO 2**
CO2	Gain a complete understanding in creation of arrays and matrices, its operations and plotting of visually appealing graphs using Python	**12**	**U**	**C**	**1,2**	**PSO 2**
CO3	Create a problem solving capability using basic techniques of numerical analysis and able to select suitable method for solving various physics problems.	**24**	**An**	**C**	**1,2**	**PSO 2**
CO4	Learn how to apply advanced python programming to visualize physical problems/ real world problems.	**12**	**Ap**	**C, P**	**1,2**	**PSO 2**

1. Introduction to Python Programming:

[Self Study -Concept of high level language, steps involved in the development of a Program- Compilers and Interpreters - Introduction to Python language: Inputs and Outputs, Variables, operators, expressions and statements - Conditionals, Iteration and looping, Functions and Modules -.Mathematical functions (math module), Formatted Printing]

Strings, Lists, Tuples, and Dictionaries- Using, creating, manipulating/modifying. Pickling. Using the file system, File input and Output, Manipulating Paths and pathnames, file system operations- open, close, Functions to read and write text or binary data, Screen input/output and redirection, Shelving objects, Defining classes, Instance variables, Methods, Class variables, Static methods and class methods, Inheritance, Private variables and private methods.(**12 hours)**

Text books for Python :
The Quick Python Book, Vernon L. Ceder , Second Edition, Manning Publications

2. Tools for maths and visualisation in Python (The numpy and pylab modules)*

Numpy module:- Arrays and Matrices – creation of arrays and matrices (arrange, line space, zeros, ones, random, reshape, copying), Arithmetic Operations, cross product, dot product , Saving and Restoring, Matrix inversion, solution of simultaneous equations, Data visualization- The Matplotlib, Module- Plotting graphs, Multiple plots, .Polar plots, Pie Charts, Plotting mathematical functions, Sine and other functions, Special functions – Bessel & Gamma, Fourier Series.(**12 hours)**

3. Numerical Methods 1*:

Interpolation: linear and polynomial interpolation, equidistant points - Newton's forward/backward difference, spline interpolation. Curve fitting- Least square fit- linear and exponential. Derivatives: Lagrange polynomials, Newton difference polynomials, finite difference approximations. Numerical integration: simple quadratures (trapezoid, Simpson). Solution of non-linear equations: closed domain methods (bisection and regulafalsi. Monte Carlo Method – Simple Integration.(**12 hours**)

4. Numerical Methods-2* :

Ordinary differential equations: Initial value problems: the first-order Euler method, the second-order single point methods (predictor), Runge-Kutta methods. Boundary value problems: the shooting method, the equilibrium method, the Numerov's method, the eigenvalue problems - the equilibrium method . Fourier transforms: discrete Fourier transforms, fast Fourier transforms.(**12 hours)**

5. Computational methods in Physics and Computer simulations)*:

Classical Mechanics: One Dimensional Motion: Falling Objects: Introduction – Formulation: from Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium, Two dimensional motion: Projectile motion (by Euler method) and Planetary motion (R-K Method), Accuracy considerations, - , Oscillatory motion – Ideal Simple Harmonic Oscillator (Euler method), Motion of a damped oscillator (Feynmann-Newton method)., Logistic maps. Monte-Carlo simulations:

value of π, simulation of radioactivity. Quantum Mechanics: 1D Schrodinger equation – wave function and eigen values. (**12 hours**)

(Visualisation can be done with matplotlib/pylab)
*(Programs are to be discussed in Python)

Text books for Numerical Methods:

1. Introductory methods of numerical analysis, S.S. Shastry , (Prentice Hall of India,1983)
2. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, New Delhi (or any other book)
3. Numerical Mathematical Analysis, J.B. Scarborough, 2008.

References:

(For Python any book can be used as reference. Moreover a number of open articles are available freely in internet. Python is included in default in all GNU/Linux platforms and It is freely downloadable for Windows platform as well. However use of GNU/Linux may be encouraged).

1. www.python.org
2. Python Essential Reference, David M. Beazley, Pearson Education
3. Core Python Programming, Wesley J Chun, Pearson Education
4. Python Tutorial Release 2.6.1 by Guido van Rossum, Fred L. Drake, Jr., editor. This Tutorial can be obtained from website http://www.altaway.com/resources/python/tutorial.pdf
5. How to Think Like a Computer Scientist: Learning with Python, Allen Downey , Jeffrey Elkner , Chris Meyers, http://www.greenteapress.com/thinkpython/thinkpython.pdf
6. Numerical Recipes in C, second Edition(1992), Cambridge University Press
7. Numerical Recipes in Fortran 77, second Edition(1992), Cambridge University Press
8. Numpy reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (and other free resources available on net)
9. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resources available on net)
10. Numerical Methods, E Balagurusamy, Tata McGraw-Hill
11. Numerical Methods , T Veerarajan, T Ramachandran, Tat MCGraw-Hill
12. Numerical Methods with Programs I BASIC, Fortran& Pascal, S BalachandraRao, C K Shantha. Universities Press
13. Numerical methods for scientists and engineers, K. SankaraRao, PHI
14. Computational Physics, V.K.Mittal, R.C.Verma&S.C.Gupta-Published by Ane Books,4821,Pawana Bhawan,first floor,24 Ansari Road,DaryaGanj,New Delhi-110 002 (For theory part and algorithms. Programs must be discussed in Python)
15. Numerical Methods in Engineering with Python by JaanKiusalaas

SECOND SEMESTER				
Course code	PHY2A02			
Name of the course	PROFESSIONAL COMPETANCY COURSE(PCC)			
Course No	Course Category Core/Compli/ Elective	Number of Credits	Number of hours of Lectures/week	Total marks (Int+Ext)
10	-	4	-	-

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Research report writing	-	**U, Ap**	**F, P**	**2,3,5**	**PSO 5**
CO2	Making of typesets	-	**U , Ap**	**F, P**	**2,5**	**PSO 5**

Latex – scientific document preparation system : Downloading and installing a LATEX distribution, Basic types of LATEX documents, Packages and use of package physics, Format words, lines, paragraphs and pages, Create lists, tables, figures and captions, Citing books and journals.

Typeset complicated equations and formulas, inserting centered and numbered equations and aligning multi-line equations, typesetting mathematical symbols such as roots, arrows, Greek letters, and different mathematical operators, math structures such as fractions and matrices. Enhance the documents by bringing color.

Activities :

1. Typeset a model question paper for M.Sc. programme
2. Develop a review paper in a format suitable for the journal “”Pramana – Journal of Physics”
3. Create a professional presentation using beamer

References:

1 A document preparation system – Latex : User’s guide and Reference manual, 2nd ed.. Leslie Lamport,Pearson Education
2 A student’s guide to the study, practice and tools of modern mathematics, Donald Bindner and Martin Erickson, CRC Press

Evaluation of this will be based on a multiple choice written examination and an internal practical.

SECOND SEMESTER				
Course code	**PHY1L01 & PHY2L03**			
Name of the course	**GENERAL PHYSICS PRACTICAL**			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
11	**CORE PRACTICAL**	**3**	**8**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand and analyze mechanical properties of materials	**18**	**U, Ap**	**P**	**1,3,5**	**PSO5**
CO2	Understand and analyze the thermal properties of materials	**18**	**U, Ap**	**P**	**1,3,5**	**PSO5**
CO3	Understand and analyze the electrical and magnetic properties of materials	**18**	**U, Ap**	**P**	**1,3,5**	**PSO5**
CO4	Understand and analyze the optical properties of materials	**18**	**U, Ap**	**P**	**1,3,5**	**PSO5**

External Practical Exam for PHY1L01&PHY2L03 together will be conducted at the end of 2nd semester

Note :

1. *All the experiments should involve error analysis. Internal evaluation to be done in the respective semesters and grades to be intimated to the controller at the end of each semester itself. Practical observation book to be submitted to the examiners at the time of examination.*
2. *Eight experiments are to be done by a student in a semester. One mark is to be deducted from internal marks for each experiment not done by the student if the required total of experiments are not done in the semesters.*
3. *The PHOENIX/EXPEYES Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may be used for the experiments wherever possible.*

(At least 16 experiments should be done, 8 each for I & II semesters)

1. Y and σ - Interference method (a) elliptical (b) hyperbolic fringes. To determine Y and σ of the material of the given specimen by observing the elliptical and hyperbolic fringes formed in an interference set up
2. Y &σ by Koenig's method
3. Variation of surface tension with temperature-Jaegar's method. To determine the surface tension of water at different temperatures by Jaegar's method of observing the air bubble diameter at the instant of bursting inside water
4. Stefan's constant-To determine Stefan's constant
5. Thermal conductivity of liquid and air by Lee's disc method.
6. Dielectric constant by Lecher wire- To determine the wave length of the waves from the given RF oscillator and the dielectric constant of the given oil by measurement of a suitable capacitance by Lecher wire setup.
7. Viscosity of a liquid - Oscillating disc method. To determine the viscosity of the given liquid by measurements on the time period of oscillation of the disc in air and in the liquid
8. Mode constants of a vibrating strip. To determine the first and second mode constants of a steel vibrating strip; Y to be measured by the Cantilever method and frequency of vibration by the Melde's string method
9. Constants of a thermocouple and temperature of inversion.
10. Study of magnetic hysteresis - B-H Curve using standard toroid / specimen in any form.
11. Maxwell's L/C bridge -To determine the resistance and inductance of the given unknown inductor byMaxwell's L/C bridge OR Anderson's Bridge – L/C and self inductance. .(The kit developed by Indian Academy of Science can also be used)
12. Susceptibility measurement by Quincke's and Guoy's methods - Paramagnetic susceptibility of salt and specimen
13. Michelson's interferometer - (a) λ and (b) d λ and thickness of mica sheet.
14. Photoelectric effect. Determination of Plank's constant
15. Frank Hertz experiment .To measure the ionization potential of Mercury by drawing current versus applied voltage.
16. Fabry Perot etalon -Determination of thickness of air film.
17. Elementary experiments using Laser: (a) Study of Gaussian nature of laser beam (b) Evaluation of beam spot size (c) Measurement of divergence (d) Diameter of a thin wire
18. Diffraction Experiments using lasers (a)Diffraction by single slit/double slit/circular aperture (b)Diffraction by reflection grating
19. Measurement of the thermal and electrical conductivity of Cu to determine the Lorents number.(The kit developed by Indian Academy of Science can also be used)
20. Passive filters .(The kit developed by Indian Academy of Science can also be used)
21. Microwave experiments - Determination of wavelength, VSWR, attenuation, dielectric constant.

22. Experiments with Lock-in Amplifier(a) Calibration of Lock In Amplifier (b) Phase sensitive detection(c) Mutual inductance determination (d) Low resistance determination.(The kit developed by Indian Academy of Science can also be used)
23. Cauchy’s constants using liquid prism
24. Forbe’s method of determining thermal conductivity
25. Zeeman effect using Fabry-Perot etalon.

Reference Books:

1. B.L. Worsnop and H.T. Flint - Advanced Practical Physics for students - Methusen& Co (1950)
2. E.V. Smith - Manual of experiments in applied Physics - Butterworth (1970)
3. R.A. Dunlap - Experimental Physics - Modern methods - Oxford University Press (1988)
4. D. Malacara (ed) - Methods of experimental Physics - series of volumes - Academic Press Inc (1988)
5. S.P. Singh –Advanced Practical Physics – Vol I & II – PragatiPrakasan, Meerut (2003) – 13th Edition
6. A.C. Melissinos and J.Napolitano, Experiments in Modern Physics, Academic Press, 2003
7. K.MuraleedharaVarier, A Practical Approach to Nuclear Physics, Narosa Publishing House (2018)

SECOND SEMESTER				
Course code	**PHY1L02 & PHY2L04**			
Name of the course	**ELECTRONICS PRACTICAL**			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
12	**CORE PRACTICAL**	**3**	**8**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the characteristics of various transistors	18	U, Ap	P	1,3,5	PSO 5
CO2	Understand the amplification properties of electronic components	18	U, Ap	P	1,3,5	PSO 5
CO3	Understand and apply the properties of OPAMPs	18	U, Ap	P	1,3,5	PSO 5
CO4	Understand and analyze the applications of digital ICs	18	U, An	P	1,3,5	PSO 5

External Practical Exam for PHY1L02&PHY2L04 together will be conducted at the end of 2nd semester. **At least 16 experiments should be done, 8 each for I& II semesters.**

1. Study the V-I characteristics of a Silicon Controlled Rectifier – Construct half-wave and full-wave circuits using SCR.
2. a). Study the V-I characteristics of UJT. Determine intrinsic stand-off ratio. Design and construct a relaxation oscillator and sharp pulse generator for different frequencies.

   b). Design and construct a time delay circuit to switch ON a suitable load driven by a SCR. Trigger the SCR using UJT.
3. a).Study the V-I characteristics of a JFET. Determine pinch-off voltage, saturation drain current and cut-off voltage of the device.

b). Design and construct a low frequency common source amplifier using JFET. Study the frequency response, measure the i/p and o/p impedances.

4. Design and construct a d.c voltage regulator using transistors and Zener diode. Study the line and load regulation characteristics for suitable o/p voltage and maximum load current.

5. Design a single stage bipolar transistor amplifier. Compare the characteristics and performance of the circuit without feedback and with a suitable negative feedback. Compare theoretical and observed magnitudes of voltage gain, i/p and o/p impedances in both cases.

6. Design and construct a differential amplifier using transistors. Study frequency response and measure i/p, o/p impedances. Also measure CMRR of the circuit.

7. a).Design and construct an amplitude modulator circuit. Study the response for suitable modulation depths. b).Design and construct a diode A.M detector circuit to recover the modulating signal from the A.M wave.

8. Design and construct two stage I.F amplifier circuit. Study the response of single and coupled stages.

9. Design and construct a Darlington pair amplifier using medium power transistors for a suitable output current. Study the frequency response of the circuit and measure the i/p and o/p impedances.

10. Design and construct a piezo-electric crystal oscillator to generate square waves of suitable frequencies. Compare designed and observed frequencies.

11. Design and construct an R.F oscillator using tunnel diode. Measure frequency of the output signal.

12. Design and construct OPAMP based summing and averaging amplifier for three suitable inputs. Compare the designed and observed outputs.

13. Design and construct a Wien bridge oscillator using OPAMP for different frequencies. Compare designed and observed frequencies.

14. Design and construct an astable multivibrator using OPAMP for suitable frequencies.

15. Design and construct a monostable multivibrator using OPAMP for suitable pulse widths.

16. Design and construct a triangular wave generator using OPAMPs for different frequencies.

17. Design and construct OPAMP based precision half and full wave rectifies. Observe the o/p on CRO and study the circuit operation.

18. Design and construct an astable multivibrator using timer IC 555. Measure frequency and duty cycle of the o/p signal.

Modify the circuit to obtain almost perfect square waves.

19. Design and construct an monostable multivibrator using timer IC 555, for different pulse widths. Compare designed and observed pulse widths.

20. Design and construct a voltage controlled oscillator using timer IC 555. Study the performance.

21. Design and construct Schmidt triggers using OPAMPS – for symmetrical and non-symmetrical LTP/UTP. Trace hysteresis curve.

22. Design and construct OPAMP based analogue integrator and differentiator. Study the response in each case.

23. a). Design and construct OPAMP based circuit for solving a second order differential equation. Study the performance.

b). Design and construct OPAMP based circuit for solving a simultaneous equation. Study the performance.

24. Design and construct Second order Butterworth Low pass, High Pass and Band Pass filters using OPAMPs. Study the performance in each case.

25. Design and construct a narrow band-pass filter for a given centre frequency using a single OPAMP with multiple feedback. Study the frequency response.

26. 4 bit D/A converter using R-2R ladder network. Realization of 4 bit A/D converter using D/A converter.

27. Study of 4 bit binary counter (IC 7493) and 4 bit decade counter(IC 7490) at various modes. Use the counters as frequency dividers.

28.Design and construct a 3 bit binary to decimal decoder using suitable logic gates. Verify the operation.

29. Set up four bit shift register IC 7495 and verify right shift and left shift operations for different data inputs.

References: Design and construction ideas may be obtained from standard electronics text books.

For further reference:

Basic Electronics and Lab Video Prof. T.S. Natarajan IIT Madras

http://nptel.iitm.ac.in/video.php?subjectId=122106025

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THIRD SEMESTER				
Course code	**PHY3C09**			
Name of the course	**QUANTUM MECHANICS – II** (72 hrs)			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
13	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Apply time independent perturbation theory as an approximation method	20	Ap	C,P	1,2,3	PSO 3
CO2	Apply variational method and WKB method as approximation methods	12	Ap	C,P	1,2,3	PSO 3
CO3	Apply time dependent perturbation theory as an approximation method	12	Ap	C,P	1,3	PSO 3
CO4	Understanding scattering theory in terms of quantum mechanics	12	U	C	1,3	PSO 3
CO5	Understanding the concepts of relativistic quantum mechanics	16	U	C	1,3	PSO 3

1. Time-Independent Perturbation Theory

Non-degenerate perturbation theory – First-order theory and Second-order theory – Examples : (1) Linear harmonic oscillator (2) Anharmonic oscillator – Degenerate perturbation theory – Two-fold degeneracy – Higher-order degeneracy – The fine-structure of hydrogen – Relativistic correction – Spin-orbit coupling - Zeeman effect – Weak-field Zeeman effect– Strong-field Zeeman effect – Intermediate-field Zeeman effect – Hyperfine splitting – Linear Stark effect in the hydrogen atom.(**20 Hours**)

Text :(1) Chapter 6, Introduction to Quantum Mechanics (Edn.2) by David. J. Griffiths,

(2) Chapter 8, section 8.3, Quantum Mechanics (Edn.4) by V. K. Thankappan

2. Variational Method and WKB Method

Bound states (Ritz method) – Linear harmonic oscillator – Helium atom – WKB wavefunction in classical region – Example :Potential well with two vertical walls – WKB wavefunction in non-classical region – Example : Tunneling – Connection formulae – Examples : (1) Potential well with one vertical wall (2) Potential well with no vertical walls. **(12 Hours)**

Text : (1) Chapter 8, section 8.2A, Quantum Mechanics (Edn.4) by V. K. Thankappan

(2) Chapter 6, Introduction to Quantum Mechanics (Edn.2) by David. J. Griffiths

3. Time-dependent perturbation theory:

First order time-dependent perturbation theory – Constant perturbation – Transition to a continuum – Fermi's Golden rule – Scattering cross section in the Born approximation – Harmonic perturbation – Radiative transitions in atoms. **(12 Hours)**

Text : Chapter 8, sections 8.4, 8.4A, 8.4B, Quantum Mechanics (Edn.4) by V. K. Thankappan

4. Scattering:

Scattering amplitude – Method of partial waves – Scattering by a central potential – Optical theorem – Scattering by a square-well potential.**(12 Hours)**

Text: Chapter 7, relevant sections, Quantum Mechanics (Edn.4) by V. K. Thankappan

5. Relativistic Quantum Mechanics

Klein-Gordon equation – First order wave equations – Weyl equation – Dirac equation – Properties of Dirac matrices – Dirac particle is spin-1/2 particle – Spinor – Equation of continuity – Dirac particle in an external magnetic field : Non-relativisitc limit – Hole theory**(16 Hours)**

Text: Chapter 10, relevant sections; Quantum Mechanics (Edn.4) by V. K. Thankappan

Textbooks:

1. Quantum Mechanics (Edn.4) : V. K. Thankappan, New Age International.
2. Introduction to Quantum Mechanics (Edn.2) : D.J. Griffiths, Pearson Education.

References :

1. Principles of Quantum Mechanics (Edn.2) : R. Shankar, Springer.
2. Introductory Quantum Mechanics: Richard L. Liboff, Pearson Education .
3. A Modern Approach to Quantum Mechanics: J S Townsend, Viva Books.

4. Quantum Mechanics : Non-Relativistic Theory (Course of Theoretical Physics Vol3): L. D. Landau and E. M. Lifshitz, Pergamon Press.
5. The Feynman Lectures on Physics Vol 3, Narosa.
6. Quantum Mechanics : Concepts and Applications (Edn.2) : NouredineZettili, Wiley.
7. Quantum Mechanics Demystified: David McMohan, McGrawHill 2006.
8. Quantum Mechanics (Schaum's Outline) :YoavPeleg*etal*. Tata McGraw Hill Private Limited, 2/e.
9. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
10. www.nptel/videos.in/2012/11/quantum-physics.html
11. https://nptel.ac.in/courses/115106066/

THIRD SEMESTER				
Course code	**PHY3C10**			
Name of the course	**NUCLEAR AND PARTICLE PHYSICS** (72 hrs)			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
14	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understanding the basics concepts about the nucleus and analyze its internal structure and properties	12	U, An	C, P	1	PSO 3
CO2	Understand and analyze the nuclear decays and their probabilities	12	U, An	C	1,3	PSO 3
CO3	Analysis of nuclear models and their reactions	19	An	C	1,3	PSO 3
CO4	Explain different methods for nuclear radiation detection and basic ideas for nuclear electronics	12	U, Ap	C	1,3	PSO 3
CO5	Gain the knowledge on elementary particles, their interactions, and experimental evidences for the existence of quarks	17	U, R	C, F	1,3	PSO 3

1. **Nuclear Forces:**

Properties of the nucleus, size, (**self - study**) binding energy, angular momentum , nuclear electromagnetic moments, nuclear excited states, The deuteron and two-nucleon scattering experimental data, simple theory of the deuteron structure, Low energy n- p scattering, characteristics of nuclear forces, spin dependence, Tensor force, scattering cross sections, partial waves, phase shift, Singlet and triplet potentials, Effective range theory, p-p scattering. (**12 hours**)

Text: K.S.Krane : "Introductory Nuclear Physics" (Wiley), (Ch. 3 and 4)

2. **Nuclear Decay:**

[**self-study** - Basics of alpha decay , schematics, and theory of alpha emission, angular momentum and parity in alpha decay]

Beta decay, Energetics of Beta decay, Fermi theory of beta decay, Comparative half life, Allowed and forbidden transitions, Selection rules, Parity violation in beta decay, Neutrino. Beta spectroscopy, Energetics of Gamma Decay, Multipole moments, Decay rate, Angular momentum and parity selection rules, Internal conversion, Lifetimes. Gamma ray spectroscopy.**(12 hours)**

Text: K.S.Krane : "Introductory Nuclear Physics" (Wiley), (Ch. 8 : Section 8 – 8.5, Ch. 9: Section 9.6,9.10, and Ch.10: 10.4,10.6-10.8)

3. **Nuclear Models, Fission and Fusion:**

Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadruple moments, Valence Nucleons, Collective structure, Nuclear vibrations, Nuclear rotations,

More nuclear models : many particle shell model, single particle state, Liquid drop Model, Semi-empirical Mass formula,

[**Self- study**: Nuclear fission, characteristics of nuclear fission, Energetics of Fission process, Fission and nuclear structure, Controlled Fission reactions.]

Fusion process, Characteristics of fusion, solar fusion, Controlled fusion reactors. Thermonuclear weapons. (**19 hours**)

Text: K.S.Krane : "Introductory Nuclear Physics" (Wiley), (Ch. 5,Ch. 13: Section 13 -13.5, Ch. 14)

4. **Nuclear Radiation Detectors and Nuclear Electronics:**

Gas detectors – introduction, features governing detection, modes of operation, Ionization chamber use of ring guards, ionization current measurements, pulse mode operated (concept only), Proportional counter and G M counter, Scintillation detector, Photo Multiplier Tube (PMT),

Semiconductor detectors: – Ge(Li), Si(Li) and surface barrier detectors, Preamplifiers, Amplifiers, (**self study**) Single channel analyzers, Multi- channel analyzers,counting statistics, energy measurements. (**12 hours**)

Text: S S Kapoor and V S Ramamurthy: "Nuclear Radiation Detectors" (Wiley) (Ch. 3: Sections 1, 2: 2.1 - 2.2, 3.3, 4.1 – 4.5, Ch. 4:Sections 1, 2, 3:3.1 - 3.5, 4.2, 5.2, 5.6,5.7, Ch.5: Sections: 1,2,2.1,2.6,4,4.1)

G.F.Knoll : "Radiation Detection and Measurement, (Fourth Edition, Wiley) (Ch.17: ections 4,5,6 and Ch.18: sections : 1,2,3)

5. **Particle Physics:**

[self-study: Four basic forces - Gravitational, Electromagnetic, Weak and Strong - Relative strengths, classification of particles]

Yukawa's theory, Conservation of energy and masses, Electric charges, Conservation of angular momentum, Baryon and lepton numbers, Conservation of strangeness, Conservation of isospin and its components, Conservation of parity, Charge conjugation, CP violation, time reversal and CPT theorem. Extremely short lived particles, Resonances - detecting methods and experiments, Internal symmetry, The Sakatamodel, SU (3), The eight fold way, Gellmann and Okubo mass formula, Quarks and quark model, Confined quarks, Experimental evidence, Coloured quarks. Grand unified theory: structure of GUT, consequences, baryogensis, quantum gravity, quantum cosmology, super unification, super symmetry, supergravity, particle physics and cosmology, super strings, general and quantum properties.(**17 hours**)

Text : (1)Y. Neeman and Y. Kirsh: "The particle hunters' (Cambridge University Press), Ch 6: 1- 3, 3.4, 7.1-10, 8.1,9. 1-7)
(2) G. D. Coughlan, J. E. Dodd and B. M. Gripalos "The ideas of particle physics – an introduction for an introduction for scientists", (Cambridge Press), Section 39.1 – 43.6.

Reference Books :

1. H.S. Hans : "Nuclear Physics – Experimental and theoretical" (New Age International, 2001).
2. G.F.Knoll : "Radiation Detection and Measurement, (Fourth Edition, Wiley , 2011).
3. G.D.Coughlan, J.E.Dodd and B.M.Gripalos "The ideas of particle physics –an introduction forscientists", (Cambridge Press)
4. David Griffiths – "Introduction to elementary particles" – Wiley (1989)
5. S.B.Patel : "An Introduction to Nuclear Physics" (New Age International Publishers)
6. Samuel S.M.Wong: "Introductory Nuclear Physics" (Prentice Hall,India)
7. B.L.Cohen : "Concepts of Nuclear Physics" (Tata McGraw Hill)
8. E.Segre : "Nuclei and Particles" (Benjamin, 1967)
9. K MuraleedharaVarier: "Nuclear Radiation Detection: Measurement and Analysis" (Narosa).

THIRD SEMESTER				
Course code	**PHY3C11**			
Name of the course	**SOLID STATE PHYSICS** (72 hrs)			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
15	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understanding various crystal structures are expected	12	U	C	1	PSO 1
CO2	Understanding lattice vibrations and how it influencing fundamental properties of materials	8	U	C	1	PSO 1
CO3	Understanding different theoretical models to explain the fundamental properties of materials	15	U	C	1,3	PSO 1
CO4	Understanding how electric and magnetic properties in materials are generated and their classification	20	U	C	1	PSO 1
CO5	Understanding different environments in which superconducting properties in materials are generated	10	An	C	1,3	PSO 1
CO6	Understanding nanomaterials and how shape or size influencing the material properties	7	U	C	1,2,3	PSO 1

1. **Crystal Structure and binding:**

Symmetry elements of a crystal, Types of space lattices, Miller indices, BCC, FCC,HCP structures with examples, Scattered wave amplitude, Reciprocal lattice vectors, Description of X-ray diffraction using reciprocal lattice, Brillouin zones, Vander Waals interaction, Cohesive energy of inert gas crystals, Madelung interaction, Cohesive energy of ionic crystals, Covalent bonding, Metallic bonding, Hydrogen-bonded crystals (12 hours)

2. **Lattice Vibrations:**

Vibrations of monatomic and diatomic lattices, Quantization of lattice vibrations, Inelastic scattering of neutrons, Einstein and Debye models of specific heat, Thermal conductivity, Effect of imperfection (8 hours)

3. **Electron States and Semiconductors:**

Free electron gas in three dimensions, Specific heat of metals, Sommerfeld theory of electrical conductivity, Wiedemann-Franz law, Hall effect, Nearly free electron model and formation of energy bands, Bloch functions, Kronig Penny model, Formation of energy gap at Brillouin zone boundaries, Number of orbitals in a band, Equation of motion of electrons in energy bands, Properties of holes, Effective mass of carriers, Intrinsic carrier concentration,. Direct band gap and indirect band gap semiconductors (15 hours)

4. **Dielectric, Ferroelectric and magnetic properties:**

Theory of Dielectrics: polarization, Dielectric constant, Local Electric field, Dielectric polarisability, Polarisation from Dipole orientation, Ferroelectric crystals, Order-disorder type of ferroelectrics, Properties of BaTiO3, Polarisation catastrophe, Displasive type ferroelectrics, Landau theory of ferroelectric phase transitions, Ferroelectric domain, Antiferroelectricity, Piezoelectricity, Applications of Piezoelectric Crystals, Diamagnetism and Paramagnetism: Langevin’s theory of diamagnetism, Langevin’s theory of paramagnetism, theory of Atomic magnetic moment, Hund‟s rule, Ferro, Anti and Ferri magnetism: Weiss theory of ferromagnetism, Ferromagnetic domains, Neel Model of Antiferromagnetism and Ferrimagnetism, Spin waves, Magnons in Ferromagnets (qualitative) (20 hours)

5. **Superconductivity:**

Meissner effect, Type I and Type II superconductors, energy gap Isotope effect, London equation and penetration of magnetic field, Cooper pairs and the B C S ground state (qualitative), Flux quantization, Single particle tunneling, DC and AC Josephson effects, High Tc Superconductors(qualitative) description of cuprates, Enough exercises. (10 hours)

6. **An introduction of nanomaterials:**

Classification of nanomaterials, size effect on shape of nanomaterials, nanorods, nanotubes, nanowires, nanoflowers, nanobrushes, quantumdots, semiconductor nanoparticles. Graphene, carbon nanotubes, nano fabrication-top-down fabrication, bottom-up fabrication, (7 hours)

Text books:

1. C.Kittel,: Introduction to Solid State Physics 5th edition (Wiley Eastern)
2. A.J.Dekker: Solid State Physics (Macmillian 1958)
3. M.S Ramachandrarao and Shubra Singh:Nanoscience and nanotechnology-fundamentals to frontiers,Wiley,2013

Reference Books:

1. M.Ali Omar, Elementary Solid State Physics, Addison-Wesley Publishing Company
2. N.W. Ashcroft and Mermin : Solid State Physics (Brooks Cole (1976)
3. Elements of Solid State Physics, Srivastava J.P. Prentice Hall of India (2nd edn)
4. Ziman J.H. Principles of Theory of Solids - (Cambridge 1964)
5. HaraldIbach and Hans Luth, Solid State Physics : An Introduction to Principles of Solid State Physics, Springer (2009)
6. Pradeep T, Nano: The Essentials Understanding Nanoscience and Nanotechnology, Tata Mc-Graw Hill, New Delhi, 2012

THIRD SEMESTER – ELECTIVE I				
Course code	**PHY3E05**			
Name of the course	**EXPERIMENTAL TECHNIQUES (72 hrs)**			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
16	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Explain the working of vacuum unit and find its applications	19	U, Ap	C, P	1, 3	PSO 4
CO2	Basic knowledge of thin film materials and its deposition technique and find its applications	14	U, Ap	C, P	1, 3	PSO 4
CO3	Understanding of various particle accelerators and its application	14	U, Ap	C, P	1, 3	PSO 4
CO4	Analysis the Materials by various nuclear techniques	15	U, Ap, An	C, P	1, 3	PSO 4
CO5	Identify the Structure of the material of by X-ray Diffraction	10	U, Ap, An	C, P	1, 3	PSO 4

1. **Vacuum Techniques**:

Units and basic definitions, Roughing pumps - Oil sealed rotary vacuum pump and Sorption pump, High vacuum pumps – Turbo molecular pump, Diffusion pump, Oil vapour booster pump, Ion pumps - Sputter ion pump and Getter ion pump, Cryo pump, Vacuum guages – Direct reading vacuum Gauges –Liquid column Manometer ,Indirect Reading Guages - Pirani gauge, Thermocouple gauge, penning guage (Cold cathodeIonization guage) and Hot filament ionization gauge, Vacuum accessories – Diaphragm, Gate valve, Butterfly valve, Baffle and isolation valves, magnetic valves, adjustable valves, air inlet valves, Traps - Liquid nitrogen trap, Sorption traps, and gaskets and O rings. General layout of a complete vacuum systems . (**19 hours**)

Text :MuraleedharaVarier et al. "Advanced Experimental Techniques in Modern Physics", Sections 1.4, 1.6 – 1.8, 1.9.1 – 1.9.1.1 ,1.9.2.3- 1.9.2.5, 1.10.1- 1.10.7, 1.10.3.1.11.

2. **Thin film techniques** :

Introduction, Fabrication of thin films, Thermal evaporation in vacuum – Resistive heating, Electron beam evaporation and laser evaporation techniques, Sputter deposition, Glow discharge, Thickness measurement by quartz crystal monitor, optical interference method, electrical conductivity measurement, Thermo electric power, Interference filters - Multi layer optical filters, Technological Applications of thin films. (**14 hours**)
Text :MuraleedharaVarier, et al. "Advanced Experimental Techniques in Modern Physics" Sections 2.1, 2.2.1.1, 2.2.1.4, 2.2.1.5, 2.2.2, 2.3.2, 2.3.3, 2.3.1, 2.7, 2.6.1

3. Accelerator techniques :

High voltage DC accelerators, Cascade generator, Van de Graaff accelerator, Tandem Van de Graff accelerator, Linear accelerator, Cyclotron, Synchrotron (Electron and proton), Ion sources – Ionization processes, simple ion source, ion plasma source and RF ion source, Ion implantation – techniques and profiles, Ion beam sputtering– principles and applications. (**14 hours**)
Text :MuraleedharaVarier, et al. "Advanced Experimental Techniques in Modern Physics", Sections 4.3, 4.4, 4.5.1, 4.5.4, 4.5.5, 4.6, 4.8.1 – 4.8.3, 4.9

4. Materials Analysis by nuclear techniques:

Introduction, Basic principles and requirements, General experimental setup, mathematical basis and nuclear reaction kinematics, Rutherford backscattering – introduction, Theoretical background – classical and quantum mechanical, experimental set up, energy loss and straggling and applications. Neutron activation analysis – principles and experimental arrangement, applications, Proton induced X-ray Emission – principle and experimental set up, applications to water samples, human hair samples and forensic samples, limitations of PIXE. (**15 hours**)

Text: Advanced Experimental Techniques in Modern Physics – K. MuraleedharaVarier, Antony Joseph and P. P. Pradyumnan, Pragati Prakashan, Meerut (2006)

5. X- Ray Diffraction Technique :

Introduction, Lattice planes and Bragg's Law, Diffractometer - Instrumentation, Single crystal and Powder diffraction, Scherrer equation, Structure factor, Applications of XRD - Crystallinity, Unit Cell Parameters, Phase transition studies, thin film studies, Awareness on Powder Diffraction File (PDF) of the International Centre for Diffraction Data. (10 hours)
Text: Elements of Modern X-ray Physics, Jens Als Nielsen and Des McMorrow, (John Wiley and Sons 2000)

Books for Reference:

1. Scientific foundations of vacuum techniques – S. Dushman and J.M. Laffer, John Wiley New York (1962)
2. Thin film phenomena – K.L. Chopra, McGraw Hill (1983)

3. R. Sreenivasan – Approach to absolute zero - Resonance magazine Vol 1 no 12,vol 2 nos 2, 6 and 10
4. R. Berry, P.M. Hall and M.T. Harris – Thin film technology – Van Nostrand (1968)
5. Dennis and Heppel – Vacuum system design
6. Nuclear Micro analysis – V. Valkovic
7. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley Inc (1978)
8. Useful Link for XRD-http://pd.chem.ucl.ac.uk/pdnn/powintro/whatdiff.htm

FOURTH SEMESTER				
Course code	PHY4C12			
Name of the course	ATOMIC AND MOLECULAR SPECTROSCOPY (72hrs)			
Course No	Course Category Core/Compli/ Elective	Number of Credits	Number of hours of Lectures/week	Internal – External ratio
17	CORE	4	4	1:4

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand various concepts in Atomic Spectroscopy	18	U	C	1	PSO 1
CO2	Understand the aspects of Microwave & IR spectroscopy	18	U	C	1	PSO 1
CO3	Understand the various aspects of linear & non-linear Raman Effect	14	U	C	1,3	PSO 1
CO4	Understand Electronic Spectroscopy of molecules	10	U	C	1,3	PSO 1
CO5	Understand the fundamental concepts of NMR, ESR and Mössbauer Spectroscopy	12	U	C	1,3	PSO 1

1. **Atomic Spectroscopy:**
   Zeeman effect – Normal & Anomalous Zeeman effect – Vector Model of a one electron system in a weak magnetic field – Magnetic moment of a bound electron – Magnetic interaction energy – Selection Rules – Intensity Rules – Paschen Back effect – Paschen Back effect of a Principal Series Doublet – Selection Rules for Paschen Back effect – Atom model for two valence electrons – ll coupling – ss coupling – LS coupling – jj coupling. (**18 hours**)

   Text: Sections10.1 to 10.9, 12.1 to 12.3, 12.6, 12.7, 12.9 –Introduction to Atomic Spectra by H E White

2. **Microwave and Infrared Spectroscopy:**

 The spectrum of non rigid rotator – spectrum of symmetric top molecule – Microwave Spectrometer – Information derived from Rotational Spectra.Vibrational energy of a diatomic molecules – zero point energy – Vibrating diatomic molecule – Fundamental & Overtone frequencies – diatomic vibrating rotator – Normal modes and vibration of H_2O and CO_2 – I.R Spectrophotometer – Fourier transformation I.R Spectroscopy: Principle, Arrangement & Advantages.**(18 hours)**

 Text: Sections 6.6, 6.9, 6.14, 6.15, 7.1, 7.4, 7.5, 7.7.1, 7.16, 7.17, 7.18 Molecular Structure and Spectroscopy, 2nd Edition by G. Aruldas

3. **Raman Spectroscopy:**

 Rotational Raman Spectrum of Symmetric top molecules – Vibrational Raman Spectra – Mutual Exclusion Principle – Raman Spectrometer – structure determination using IR and Raman SpectroscopyNon-linear Raman Effects, Hyper Raman Effect, Stimulated Raman Effect and Inverse Raman Effect.**(14 hours)**

 Text: Sections 8.3.2, 8.4, 8.5, 8.6, 8.7, 8.12, 15.1, 15.5, 15.6, 15.7 Molecular Structure and Spectroscopy, 2nd Edition by G. Aruldas

4. **Electronic Spectroscopy of molecules:**

 Vibrational Analysis of band systems – Deslander's table – Progressions & Sequences – Information derived from vibrational analysis – Franck Condon Principle – Rotational fine structure of Electronic-Vibration Spectra – Fortrat Parabolae**(10 hours)**

 Text: Sections 9.3, 9.4, 9.5, 9.6, 9.7, 9.8 Molecular Structure and Spectroscopy, 2nd Edition by G. Aruldas

5. **Spin Resonance Spectroscopy:**

 Nuclear Magnetic Resonance: Magnetic Properties of Nuclei – Resonance Condition – NMR Instrumentation – Relaxation Processes – spin spin and spin lattice relaxation – Bloch equations – Chemical Shift. **Electron Spin Resonance:** Principle of ESR – Resonance condition – ESR Spectrometer. **Mössbauer Spectroscopy:** Recoilless emission & absorption – Isomer Shift.**(12 hours)**

 Text: Sections 10.1, 10.2, 10.3, 10.5, 10.6, 10.8, 11.1, 11.2, 11.3, 13.1, 13.3 Molecular Structure and Spectroscopy, 2nd Edition by G. Aruldas

Text Books:

1. Introduction to Atomic Spectra by H E White, McGraw Hill Book Company, New York & London, 1934.

2. Molecular Structure and Spectroscopy, 2nd Edition by G. Aruldas, PHI Learning Private Limited, New Delhi, 2011.

References:

1. C. N. Banwell& E. M. Mccash – Fundamentals of Molecular Spectroscopy
2. G. M. Barrow – Introduction to Molecular Spectroscopy
3. Straughan and Walker – Spectroscopy , Volume I, II and III
4. H. H. Willard – Instrumental Methods of Analysis, 7th Edition, CBS-Publishers, New Delhi.
5. Atomic Spectroscopy – K P Rajappan Nair, MJP Publishers, Chennai
6. Elements of spectroscopy – Gupta & Kumar, PragatiPrakasan, Meerut

FOURTH SEMESTER – ELECTIVE II				
Course code	**PHY4E13**			
Name of the course	**LASER SYSTEMS, OPTICAL FIBERS AND APPLICATIONS (72hrs)**			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
18	**CORE**	**4**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Discuss theory of lasing action	18	U	C, P	1	PSO 4
CO2	Illustrate various laser systems and compare their working principle.	12	An, Ap	C, P	1,3	PSO 4
CO3	To outline various nonlinear process and to design various experimental techniques	14	U, C	C, P	1,3	PSO 4
CO4	To illustrate various application of lasers	13	Ap	C, P	1,2	PSO 4
CO5	Understand and explain optical fibers and its applications	15	U	C, P	1,2	PSO 4

1. **Basic laser theory:** [Self - study - Stimulated emission, Spontaneous emission, population inversion, Basic laser theory, Introduction] Einstein coefficients, Light amplification, The threshold condition, Line broadening mechanisms, Laser rate equations, Theory of Q-switched and Modelocked lasers, Cavity modes, stable and unstable resonators, Analysis of optical resonators.**(18 hours)**

2. **Various laser systems:** Ruby, Nd:YAG, Argon ion, He-Ne, CO2 laser, Fiber Laser, Semionductor Lasers, Optical parametric Oscillator – Working principle and energy level diagrams.**(12 hours)**

3. **Nonlinear optics:**

Nonlinear polarization, Second and third Harmonic generation, Symmetry requirement for second Harmonic generation, Nonlinear refractive index, Thermal Nonlinear Optical Effects, two photon absorption, three photon absorption, excited state absorption, saturable absorption, reverse saturable absorption, Multi photon absorption, Nonlinear materials, Four wave mixing and Z-scan Technique, closed aperture zscan technique, open aperture z-scan technique **(14 hours)**

4. **Laser Applications:**

Spatial frequency filtering, Holograpy, Industrial application of lasers, Lasers in medicine, Isotope separation, laser induced chemical reactions, Laser induced fusion.**(13 hours)**

5. **Optical Fibers:** [self-study: what are optical fibres and its applications]

Propagation of light in optical fibers, Basic structure, Acceptance angle, Numerical aperture, Stepped index monomode fibers, disadvantages, Graded index monomode fibers, Optical fibers as cylindrical waveguides, Scalar wave equation and the modes of a fiber, Modal analysis for a step index fiber, Single mode fibers. (**15 hours**)

Textbooks:

1. K.Thyagarajan and AjoyGhatak : "LASERS :Fundamentals and Applications" (2nd Edition,Springer, 2010)

2. William T Silfvast :" Laser fundamentals" (2nd Edition, Cambridge University Press, 2004))

3. B.B Laud : "Lasers and Nonlinear Optics" (3rd Edition, New age international Publishers, 2011)

4. Ajoy Ghatak and K. Thyagarajan "Optical Electronics" (Cambridge University Press, 1989)

5. John. M.Senior : "Optical Fiber Communications: Principles and Practice" (3rd Edition, Pearson Education India, 2009)

Reference books

1. Subirkumar Sarkar :"Optical Fiber and Fiber Optic Communication Systems" (S. Chand & Co.)

2. Ajoy Ghatak and K.Thayagarajan : Introduction to Fiber Optics" (Cambridge University Press, 1998)

FOURTH SEMESTER – ELECTIVE III				
Course code	PHY4E20			
Name of the course	MICROPROCESSORS, MICRO CONTROLLERS AND APPLICATIONS (72 hrs)			
Course No	Course Category Core/Compli/ Elective	Number of Credits	Number of hours of Lectures/week	Internal – External ratio
19	CORE	4	4	1:4

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Introduction to intel 8085 and its programming	12	U	C	1	PSO 4
CO2	Understanding the timing and interfacing of memory and I/O devices	10	U	C	1,2	PSO 4
CO3	Gain knowledge on chips used for interfacing	16	U	C	1	PSO 4
CO4	Acquire the basic knowledge about microcontrollers and Programming and analyze on its applications	16	U, An	C, P	1,2	PSO 4
CO5	Understand the basic concept of AVR programming and its applications	18	U, Ap	C, P	1,2	PSO 4

1. Microprocessor and Assembly language programming :

[self– study: Microprocessor as CPU, Internal architecture of Intel 8085]

Instruction set, Addressing modes,(Assembly and high level language, stack subroutine) Examples of Assembly language programming, Addition and subtraction of 2 byte numbers, multiplication and division of 1 byte numbers, square from the look up table, Sorting of 1 byte numbers : ascending and descending order. (**12 hours**)

Text: 1. Introduction to Microprocessors–A.P. Mathur (Tata-McGraw Hill). Section 3.3.

2. Fundamentals of Microprocessors and Micro Computers"– B. Ram - Dhanapati Rai, Sections 3,3.1,4.1,4.2,5-5.6,6.1-6.7,6.19-25

2. **Microprocessor timings; Interfacing memory and I/O devices:**

[self– study:Instruction cycles]

Machine cycles and timing diagram, address space partitioning, generation of control signals for memory and I/O device interfacing, memory interfacing, I/O device interfacing, Address decoding using 74LS138, data transfer groups and interrupts. (**10 hours**)

Text: 1. "Introduction to Microprocessors" –A.P. Mathur (Tata-McGraw Hill), Sections: 5.2-5.3.

2. Fundamentals of Microprocessors and Micro Computers"– B. Ram- Dhanapati Rai, Chapter 3 and Section 7.1- 7.6.

3. **Peripheral devices and interfacing :**

[**self-study**: Display of alpha numeric characters.] I/O ports, Programmable Peripheral Interface- Intel 8255, Programmable Interval Timer- Intel 8253, Programmable DMA controller- Intel 8257, Programmable Interrupt controller- Intel 8259.A/D converter: clock, S/H, analog multiplexer ADC interfacing - General idea with block diagram, Delay subroutine,7 segment LED display interfacing – General idea of display and driver,**(16 hours)**

Text: 1. Fundamentals of Microprocessors and Micro Computers– B. Ram – DhanapatiRai, Sections: 7.6-7.9,7.11, 8.2-8.6,9.2,9.3.

2. Introduction to Microprocessors –A.P. Mathur (Tata-McGraw Hill).

4. **Microcontrollers and Programming :**

[self–study: Numerical and coding systems, addition and subtraction of hex numbers, logic gates, flip flops, semiconductor memory : RAM, ROM]

Microcontroller vs microprocessor, microcontrollers in embedded systems. Overview of AVR family of microcontrollers, simplified block diagram of AVR microcontroller, General idea of ROM, RAM, EEPROM, I/O pins and peripherals in microcontroller.AVR architecture and Assembly level programming – General purpose registers, Data memory and instructions, status register and instructions, branch instructions, call and time delay loops; Assembler directives, sample programs.
Arithmetic and logical instructions – sample programs.

Text: 1. The AVR microcontroller and embedded systems – using Assembly and C. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi, Prentice Hall – Pearson, Chapters 1,2.1 – 2.5, and 5)

5. **AVR Programming :**

[Self- study: AVR advanced assembly language programming assembler directives, register and direct addressing modes, indirect addressing modes.]

I/O programming, I/O port pins and functions, features of ports A, B, C and D, dual role of Ports, sampleprograms. I/O ports and bit addressability.AVR programming in C:C language data types for AVR, C programs for arithmetic, logic time delay and I/O operations. **(18 hours)**

Text : The AVR microcontroller and embedded systems – using Assembly and C. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi, Prentice Hall – Pearson, Chapters 4 and 7)

Textbooks:

1. Introduction to Microprocessors–A.P. Mathur (Tata-McGraw Hill).
2. Fundamentals of Microprocessors and Micro Computers”– B. Ram- DhanapatiRai
3. Microprocessors – Architecture, Programming and Applications with 8085 - R.S.Gaonkar (Wiley Eastern)
4 .The AVR microcontroller and embedded systems – using Assembly andC. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi, Prentice Hall - Pearson

Ref: 1. Programming and customizing the AVR microcontroller: Dhananjay V Gadre.
2. Embedded C programming and the Atmel AVR: Barnett, Cox, O’Cull.

FOURTH SEMESTER				
Course code	**PHY3L05 & PHY4L06**			
Name of the course	**MODERN PHYSICS PRACTICAL**			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
20	**CORE PRACTICAL**	**3**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the nuclear physics experiments	16	U, Ap	P	2,3,5	PSO 5
CO2	Understand different experimental techniques	16	U, Ap	P	2,3,5	PSO 5
CO3	Understand the advanced electronics experiments	14	U, Ap	P	2,3,5	PSO 5
CO4	Understand the basics of lasers and fiber experiements	14	U, Ap	P	2,3,5	PSO 5
CO5	Understand the basics of spectroscopy	12	U, Ap	P	2,3,5	PSO 5

External Practical Exam for PHY3L05 & PHY4L06 together will be conducted at the end of 4th semester.

*At least **10** experiments are to be done from **Part A** and **2** each from the elective paper as listed in **Part B**. If no practicals have been given for a particular elective papers, two more experiments from Part A should be done. It may be noted that some experiments are given both in Part A and B – of course such experiments can be done only once: either as included in part A or in part B. Internal evaluation to be done in each semester and final grades to be intimated to the controller at the end of 2nd and 4th semesters. One mark is to be deducted from internal marks for each experiment not done by the student if the required total number of experiments are not done in the semesters. The PHOENIX/EXPEYES Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may be used for experiments wherever possible.*

PART A

1. G.M. Counter plateau and statistics of counting - To obtain the plateau, operating voltage and to verify the distribution law satisfied by the radioactive decay
2. Absorption coefficient for beta & gamma rays -To determine the absorption coefficient of the given materials using a G. M. Counter
3. Feather analysis – End point energy - To determine the end point energy of the beta particles from a given source using Feather analysis
4. Scintillation counter - To calibrate the given gamma ray (scintillation) spectrometer using standard gamma sources and to determine the energy of an unknown gamma ray source
5. Compton scattering - To verify the theoretical expression for the energy of the Compton scattered gamma rays at a given angle using a Scintillation gamma spectrometer / determine the rest mass energy of the electron
6. Half life of Indium – thermal neutron absorption - To determine the half life of In-116 by irradiation of In foil and beta counting using a GM counter
7. Photoelectric effect in lead - To get the spectrum of X rays emitted form lead target by photo electric effect using Cs-137 gammas
8. Conductivity, Reflectivity, sheet resistance and refractive index of thin films
9. Hall effect in semiconductors-To determine the carrier concentration in the given specimen of semiconducting material
10. ESR spectrometer – Determination of g factor
11. Rydberg constant determination
12. Absorption spectrum of KMnO4 and Iodine. To determine the wavelength of the absorption bands of KMnO4 and to determine the dissociation energy of iodine molecule from its absorption spectrum.
13. Ionic conductivity of KCl/NaCl crystals
14. Curie Weiss law -To determine the Curie temperature
15. To study the Thermoluminescence of F-centres of Alkali halides
16. Variation of dielectric constant with temperature of a ferroelectric material (Barium Titanate)
17. Polarization of light and verification of Malu‟s law.
18. Refractive index measurement of a transparent material by measuring Brewster‟s angle
19. Measurement of the thermal relaxation time constant of a serial light bulb.
20. Dielectric constant of a non polar liquid
21. Vacuum pump – pumping speed
22. Pirani gauge – characteristics
23. Ultrasonic interferometer. To determine the velocity and compressibility of sound in liquids.
24. Study of LED characteristics - Determination of wavelength of emission, I-V characteristics and variation with tempearture, variation of output power vs. applied voltage
25. Optical fibre characteristics - To determine the numerical aperture, attenuation and band width of the given optical fibre specimen
26. Band gap energy of Ge by four probe method.-To study bulk resistance and to determine band gap energy.

27. Thomson"s e/m measurement.-To determine charge to mass ratio of the electron by Thomson"s method.
28. Determination of Band gap energy of Ge and Si using diodes.
29. Millikan"s oil drop experiment .To measure the charge on the electron.
30. Zener voltage characteristic at low and ambient temperatures – To study the variation of the Zener voltage of the given Zener diode with temperature
31. Thermionic work function – To determine the thermionic work function of the material of the cathode of the given vacuum diode/triode from the characteristic at different filament currents

PART B

I . ADVANCED ELECTRONICS

1. Simple temperature control circuit
2. Binary rate multiplier
3. Optical feedback amplifier
4. Frequency modulation and pulse modulation
5. Binary multiplier
6. Write ALP and execute using 8085 kit for generating a square wave of desired frequency using PPI 8255 interfacing. observe the output on CRO and measure frequency.
7. Write ALP to alternately switch on/off a green and a red LED within a given small time interval. Execute using 8085 kit.
8. Write ALP to convert a given d.c voltage (between 0 and 5 V) using ADC 0800/0808 interfaced to 8085 microprocessor. Execute using the given kit and check the result.

II EXPERIMENTAL TECHNIQUES

1. Rydberg constant – hydrogen spectrum
2. ESR – Lande g factor
3. IR spectrum of few samples
4. Vacuum pump – pumping speed
5. Vacuum pump – Effect of connecting pipes
6. Absorption bands of Iodine
7. Vibrational bands of AlO
8. Pirani gauge – characteristics
9. Thin films – electrical properties (sheet resistance)
10. Thin films – optical properties (Reflectivity, transmission, attenuation, refractive index)

III. LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

1. Optical fibre characteristics (Numerical aperture, attenuation and bandwidth)
2. Optical feed back circuit (Feedback factor, gain and frequency response
3. Determination of size of lycopodium particles by Laser diffraction

Reference Books for PHY 305 & PHY 405 :

1. B.L. Worsnop and H.T. Flint – Advanced Practical Physics for students – Methusen& Co (1950)
2. E.V. Smith – Manual of experiments in applied Physics – Butterworth (1970)
3. R.A. Dunlap – Experimental Physics – Modern methods – Oxford University Press (1988)
4. D. Malacara (ed) – Methods of experimental Physics – series of volumes – Academic Press Inc (1988)
5. A.C.Melissinos, J.Napolitano - Experiments in Modern Physics -Academic Press 2003.

FOURTH SEMESTER				
Course code	**PHY4L07**			
Name of the course	**COMPUTATIONAL PHYSICS PRACTICAL**			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Internal – External ratio**
21	**CORE PRACTICAL**	**3**	**4**	**1:4**

COURSE OUTCOMES

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Development of numerical method for problem solving	16	Ap	P	2,3,5	PSO5
CO2	Understanding pyhton language	16	Ap	P	2,3,5	PSO5
CO3	Skill in writing program	16	Ap	P	2,3,5	PSO5
CO4	Familarization with computer	16	Ap	P	2,3,5	PSO5
CO5	Applications of python in physics problems	8	Ap	P	2,3,5	PSO5

*The programs are to be executed in Python. For visualization Pylab/matplotlib may be used. At least **10** experiments are to be done, opting any **5** from **Part A** and another 5 from **Part B**. The Practical examination is of **6** hours duration.*

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Part A

1. Interpolation : To interpolate the value of a function using Lagrange’s interpolating polynomial
2. Least square fitting :To obtain the slope and intercept by linear and Non-linear fitting.
3. Evaluation of polynomials. Bessel and Legendre functions: Using the series expansion and recurrence relations.
4. Numerical integration : By using Trapezoidal method and Simpson’s method
5. Solution of algebraic and transcendental equations .Newton Raphson method, minimum of a function
6. Solution of algebraic equation by Bisection method
7. Matrix addition, multiplication, trace, transpose and inverse
8. Solution of second order differential equation- RungeKutta method

9. Monte Carlo method : Determination of the value of π by using random numbers
10. Numerical double integration
11. Solution of parabolic/elliptical partial differential equations

    (e.g.: differential equations for heat and mass transfer in fluids and solids, unsteady behaviour of fluid flow past bodies, Laplace equation etc.,)

Part B

1. To plot the trajectory of a particle moving in a Coulomb field (Rutherford scattering) and to determine the deflection angle as a function of the impact parameter
2. Generate phase space plots - To plot the momentum v/s position plots for the following systems : (i) a conservative case (simple pendulum) (ii) a dissipative case (damped pendulum)
3. Simulation of the wave function for a particle in a box - To plot the wave function and probability density of a particle in a box; Schrödinger equation to be solved and eigen value must be calculated numerically.
4. Simulation of a two slit photon interference experiment : To plot the light intensity as a function of distance along the screen kept at a distance from the two slit arrangement.
5. Trajectory of motion of (a) projectile without air resistance (b) projectile with air esistance
6. Logistic map function – Solution and bifurcation diagram
7. Experiment with Phoenix/expEYES kit - Time constant of RC circuits by curve fitting. *
8. Experiment with Phoenix/expEYES kit - Fourier analysis of different waveforms captured using the instrument. *
   (*If Phoenix is not available, data may be given in tabulated form)
9. Simulation of Kepler's orbit and verification of Kepler's laws.
10. Simulations of small oscillations in simple molecules:: Diatomic molecule/Triatomic molecule for various lengths(any one case)
11. Simulation of random walk in 1D/2D and determination of mean square distance.
12. Simulation of magnetic field - To plot the axial magnetic field v/s distance due to a current loop carrying current.
13. Simulation of the trajectory of a charged particle in a uniform magnetic field.
14. Simulation of polarisation of electromagnetic waves.
15. Simulation of coupled oscillators - Phase space portraits.

Textbooks :

1. Computational Physics -An introduction., R.C.Varma, P.K.Ahluwalia andK.C.Sharma, New Age International Publishers
2. Numpy Reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (also, free resources available on net)
3. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resourcesavailable on net)
4. Numerical Methods in Engineering and Science, Dr. B S Grewal,

Khanna Publishers, New Delhi (or any other book)
5. Numerical Methods, E Balagurusamy, Tata McGraw-Hill
6. Numerical Methods , T Veerarajan, T Ramachandran, Tat MCGraw-Hill
7. Numerical Methods with Programs I BASIC, Fortran & Pascal, S BalachandraRao, C K Shantha. Universities Press
8. Numerical methods for scientists and engineers, K. SankaraRao, PHI
9. Introductory methods of numerical analysis, S.S.Shastry , (Prentice Hall of India,1983)
10. Numerical Methods in Engineering with Python by JaanKiusalaas

Note: Experiments from Part A can be done with data from physical situations where ever possible. For example consider the following cases.

a) The load W placed on a spring reduces its length L. A set of observations are given below. Calculate force constant and length of the spring before loading

W(kg)	0.28	0.51	0.67	0.93	1.15	1.38	1.6	1.98
L(cm)	6.62	5.93	4.46	4.25	3.3	3.15	2.43	1.46

b) The displacements of a particle at different instants are given below. What is the time instant at which the displacement is 70.2 m

t(s)	1.0	2.2	3.01	4.5	5.8	6.7	7.6	8.3	9.4
s(m)	3.0	10.56	19.07	37.12	59.16	77.38	98.04	115.78	146.6

PATTERN OF QUESTION PAPER

(for Core and Elective courses in I/II/III/IV SemM.Sc Physics (**CBCSS-PG**) w.e.f. 2020)

Code : (eg. PHY1C01) Subject (eg. Classical Mechanics)

Time: 3 Hours. **Total weightage: 30**

Section A

(8 Short questions, each answerable within 7.5 minutes)
Answer **ALL** questions, each carry weightage 1)

QUESTION NUMBERS1TO8 Total weightage 8x1=8

Section B

(4 Essay questions, each answerable within 30 minutes)

Answer **ANY TWO** questions, each carry weightage 5)

QUESTION NUMBERS9TO 12 Total weightage 2x5=10

Section C

(7 Problem questions, each answerable within 15 minutes)

Answer **ANY FOUR** questions, each carry weightage 3)

QUESTION NUMBERS 13 TO 19 Total weightage 4x3=12

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code: PHY1C01: CLASSICAL MECHANICS							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			17Hrs	**19 Hrs**	**14 Hrs**	**9 Hrs**	**13 Hrs**
			13 Weightage	**13Weightage**	**9 Weightage**	**5Weightage**	**9 Weightage**
Expected Weightage >>>>							
I	**1**	**1**	1				
		2	1				
		3		1			
		4		1			
		5			1		
		6				1	
		7				1	
		8					1
II	**5**	**9**	1				
		10		1			
		11			1		
		12					1
III	**3**	**13**	1				
		14	1				
		15		**1**			
		16		1			
		17			1		
		18				1	
		19					1
Actual Weightage >> >>			**13**	**13**	**9**	**5**	**9**

M.Sc. Physics/2020 Admission onwards

Name..............................

Reg.No...........................

ST. THOMAS' COLLEGE (AUTONOMOUS), THRISSUR

FIRST SEMESTER M.Sc. DEGREE EXAMINATION……………..

PHY IC 01 – CLASSICAL MECHANICS

Time : 3 Hours | Maximum : 30 Weightage

Part A

*Answer **all** questions.*

*Each question carries **a** weightage of **one***

1. What are generalized co-ordinates?
2. Is the Lagrangian formulation more advantages than the Newtonian formulation? Why?
3. What is the connection between Hamiltonian- Jacobi equation and Schrodinger equation?
4. List the fundament properties of Poisson's brackets.
5. Distinguish between space fixed and body fixed system of co-ordinates.
6. What is meant by normal co-ordinates?
7. What is meant by stable and unstable equilibriums in the case of small oscillations? Give examples.
8. Briefly explain chaotic attractors.

(8 × 1 = 8 weightage)

Part B

*Answer **any two** questions.*

*Each question carries a weightage of **five***

9. What is meant by action and angle variable? Discuss the Harmonic oscillator problem using action and angle variable technique.
10. State D'Alembert's Principle. Derive Lagrange's equation of motion from it.
11. Derive Euler's equation of motion for rigid bodies. Explain the force free motion of a symmetric top.
12. Obtain the non-linear equation for a pendulum. Derive the exact solution of the equation in terms of elliptic integral.

(2 × 5 = 10 weightage)

Part C

*Answer any **four** questions.*

*Each question carries a weightage of **three***

13. A particle of mass m moves on the side of a frictionless cone of equation $x^2 + y^2 = z^2 tan^2 \alpha$. Find out the Hamiltonian of the paricle.
14. Prove Jacobi's identity.

15. For the following Poisson brackets prove that (i) [(a.r), (b.p)]=a.b (ii) [J, (r.p)] =0 (iii) $[r^n$, p]= n$r^{n-2}\vec{r}$
16. Show that the transformation is canonical Q= $\sqrt{2q}e^{\alpha}$cosP and P= $\sqrt{2q}e^{-\alpha}$ sinP is a canonical transformation.
17. A person in a Jet plane is flying along the equator due East with a speed of 300 m/s. what is his Coriolis acceleration?
18. A particle of mass m is at the stable equilibrium position of its potential energy V(x)= ax - bx^3, where a and b are positive constants. What is the minimum velocity that has to be imparted to the particle to render its motion?
19. Solve the system of equations

$$\dot{x} = -y + x(\dot{x}^2 + y^2 - 1);$$
$$\dot{y} = -x + y(\dot{x}^2 + y^2 - 1);$$

Sketch the phase space trajectories and show that there exists a limit cycle which is unstable.

(4 × 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code: **(PHY1C02) Mathematical Physics – I**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			11 Hrs	**11 Hrs**	**14 Hrs**	**24 Hrs**	**12 Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	**1**	**1**	1				
		2		1			
		3		1			
		4			1		
		5			1		
		6				1	
		7				1	
		8					1
II	**5**	**9**	1				
		10		1			
		11			1		
		12				1	
III	**3**	**13**	1				
		14		1			
		15				1	
		16				1	
		17				1	
		18					1
		19					1
Actual Weightage >> >>			**9**	**10**	**7**	**16**	**7**

M.Sc. Physics/2020 Admission onwards

Name……………………………

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ST. THOMAS' COLLEGE (AUTONOMOUS), THRISSUR
FIRST SEMESTER M.Sc. DEGREE EXAMINATION………………

PHY IC 02 – MATHEMATICAL PHYSICS – I

Time :3 Hours Maximum : 30 Weightage

Part A

*Answer **all** questions.*
*Each question carries **a** weightage of **one***

1. Prove that a cylindrical coordinate system is orthogonal.
2. Define symmetric and antisymmetric matrices. Show that any square matrix may be written as the sum of a symmetric matrix and an antisymmetric matrix.
3. Show that Kronecker delta is a mixed tensor of rank 2.
4. What is a Hermitian operator? State the properties of this operator.
5. What is meant by singular point of a differential equation?
6. Define Γ function. By direct integration show that $\Gamma(n+1) = n\,\Gamma(n)$
7. Prove that $H_n(-x) = (-1)^n H_n(x)$
8. Why Laplace transform L is called a linear operator?

(8 × 1 = 8 weightage)

Part B

*Answer **any two** questions.*
*Each question carries a weightage of **five***

9. Explain Orthogonal curvilinear coordinates. Derive an expression for Gradient and Divergence in this system.
10. (i) Explain Hermitian and Unitary matrices with examples.

 (ii)Discuss the procedure of diagonalization of matrices.
11. Obtain a series solution of equation $\frac{d^2y}{dx^2} + x^2 y = 0$ using Frobenius method.
12. Derive the Orthogonality relation for Legendre polynomial.

(2 × 5 = 10 weightage)

Part C

*Answer any **four** questions.*

*Each question carries a weightage of **three***

13. Express $\nabla \times \vec{A}$ in Spherical Polar Coordinates.
14. Define contravariant, covariant and mixed tensors. Give examples.
15. Show that $\beta(m,n) = \int_0^\infty \frac{y^{m-1}}{(1+y)^{m+n}} dy$
16. Show that $\left[J_{\frac{1}{2}}(x)\right]^2 + \left[J_{-\frac{1}{2}}(x)\right]^2 = \frac{2}{\pi x}$
17. The Legendre polynomials are defined in terms of its generating function $F(x,t) = (t - 2xt + t^2)^{-\frac{1}{2}}$ as follows:

    a. $F(x,t) = \sum_{n=0}^{\infty} P_n(x) t^n$
18. Show that the function $f(x) = \begin{cases} 0 \ for \ -\pi \leq x < 0 \\ x \ \ for \ \ 0 \leq x < \pi \end{cases}$

    a. can be expanded in Fourier series as

    b. $f(x) = \frac{\pi}{4} - \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{\cos(2n-1)x}{(2n-1)^2} - \sum_{n=1}^{\infty} (-1)^n \frac{\sin nx}{n}$

    Hence show that $1 + \frac{1}{3^2} + \frac{1}{5^2} + \cdots = \frac{\pi^2}{8}$
19. Find the Laplace's transform of the following functions:

    (i) $e^{-3x}(2\cos 5x - 3\sin 5x)$ and (ii) $e^{4x} \sin 2x \cos x$

(4 × 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **PHY1C03: ELECTRODYNAMICS AND PLASMA PHYSICS**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			14Hrs	**13Hrs**	**14 Hrs**	**15 Hrs**	**16 Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
		2	1				
		3		1			
		4		1			
		5			1		
		6				1	
		7					1
		8					1
II	5	**9**		1			
		10			1		
		11				1	
		12					1
III	3	**13**	1				
		14		1			
		15		1			
		16			1		
		17				1	
		18				1	
		19					1
Actual Weightage >> >>			5	13	9	12	10

M.Sc. Physics/2020 Admission onwards

(Pages:2) Name: ………………………

Reg. No…………………….....

ST. THOMAS' COLLEGE (AUTONOMOUS), THRISSUR

FIRST SEMESTER M.Sc. DEGREE EXAMINATION……………..

PHY1 C03 – ELECTRODYNAMICS AND PLASMA PHYSICS

Time: 3 Hours Maximum: 30 Weightage

Part A

(*Answer **all** questions. Each question has **1** weightage***)**

1. Write down the time – harmonic Maxwell's equations in terms of vector field phasors and source phasors for a linear, isotropic and homogenous medium.
2. Define group velocity. Explain the cases in which the group velocity is different from the phase velocity.
3. Explain the case in which the finite transmission line is matched.
4. Obtain an expression for quality factor of a parallel resonant circuit with well insulated line.
5. Single conductor waveguides cannot support TEM waves. Why?
6. Write down the electromagnetic field tensor $F^{\mu\nu}$ and the dual tensor $G^{\mu\nu}$.
7. It is not useful to consider plasma as a magnetic medium. Justify.
8. Write short note on plasma oscillations.

(8 x 1 = 8 weightage)

Part B

(*Answer any **two** questions. Each question has **5**weightage***)**

9. Discuss in detail, the reflection and transmission of an e.m. wave incident normally at a plane dielectric boundary. Mention the important theoretical observations.
10. Discuss the propagation of TE waves in a rectangular waveguide and obtain an expression for the cut-off frequency and phase velocity.
11. Formulate Maxwell's equations in relativistic notations.
12. Describe the Debye shielding in plasma. Derive an expression for Debye length and explain plasma in terms of Debye length.

(2 x 5 = 10 weightage)

Part C

(*Answer any* ***four*** *questions. Each question has* ***3*** *weightage*)

13. A plane wave of angular frequency ω and wave number |**K**| propagates in a neutral, homogenous, anisotropic, non conducting medium with $\mu = 1$. Show that **H** is orthogonal to **E**, **D** and **K**, and also that **D** and **H** are transverse but **E** is not.
14. Show that $E^2 - c^2B^2$ is relativistically invariant.
15. Prove that the magnetic field lags behind the electric field by 45^0, when uniform plane waves propagate in a good conductor.
16. A signal generator of internal resistance 1ohm with an open circuit voltage of $0.6\cos(2\pi 10^8 t)$ V is connected to a 100 ohm lossless transmission line of 4m long. The wave propagates on the line with a velocity of 3.5 x 10^8m/s. Find the instantaneous expressions for the voltage and current at an arbitrary location on the line, for a matched load.
17. Find the maximum amount of 20 GHz average power that can be transmitted through an air filled rectangular waveguide a = 2.2cm, b = 1.5cm at the TE_{10} mode without a breakdown.
18. Describe magnetism as a relativistic phenomenon by considering the force between current carrying wire and a moving charge.
19. For a low density plasma, the dispersion relation is given by $\omega^2 = \omega_0^2 + c^2k^2$, where k is the wave vector and ω_0 the plasma frequency. Derive a relation between the phase velocity and group velocity of the plasma.

(4 x 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **PHY1C04: Electronics**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			10Hrs	**14Hrs**	**12 Hrs**	**14Hrs**	**22Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
		2	1				
		3		1			
		4			1		
		5					1
		6					1
		7					1
		8					1
II	5	**9**		1			
		10			1		
		11				1	
		12					1
III	3	**13**	1				
		14	1				
		15		**1**			
		16				1	
		17				1	
		18					1
		19					1
Actual Weightage >> >>			**8**	**9**	**6**	**11**	**15**

M.Sc. Physics/2020 Admission onwards

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ST. THOMAS' COLLEGE (AUTONOMOUS), THRISSUR
FIRST SEMESTER M.Sc. DEGREE EXAMINATION………………..
PHY IC 04 – ELECTRONICS

Time : 3 Hours | Maximum : 30 Weightage

Part A

*Answer **all** questions.*
*Each question carries **a** weightage of **one***

1. Explain the working of FET as VVR.
2. Describe the device operation of TED.
3. Explain the principle of working of a tunnel diode .
4. Discuss the working of photo detectors.
5. Define a) input offset voltage and b) input offset current.
6. List the causes of the slew rate and explain its significance in application of OPAMP.
7. The program status word of 8085 is BC. What are the contents of different flags?
8. Draw the Block diagram and Timing diagram of MOD 16 counter.

(8 × 1 = 8 weightage)

Part B

*Answer **any two** questions.*
*Each question carries a weightage of **five***

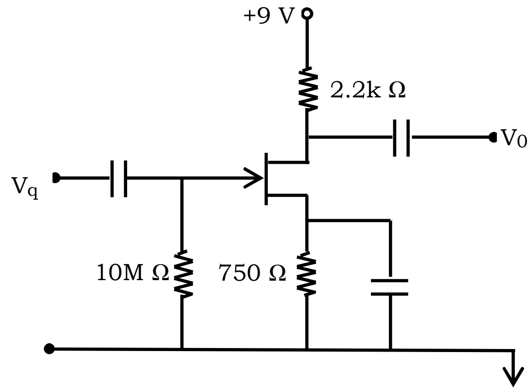
9. Discuss the operating principle of Solar cell stating clearly what is meant by short circuit current, fill factor and efficiency.
10. Discuss the frequency compensation techniques explaining dominant pole, pole zero and lead compensation.
11. Discuss the working of practical integrator and differentiator with neat diagram. Explain how a weignbridge oscillator oscillates.
12. Draw the pin diagram of 8085 and explain the function of each pin. Describe the classification of 8085 instruction depending on length.

(2 × 5 = 10 weightage)

Part C

*Answer any **four** questions.*
*Each question carries a weightage of **three***

13. Calculate the voltage gain of the common source amplifier shown in the figure. The data sheet gives the following values Y_{gs}=30 μS, I_{DSS}=7.5 mA, V_P = 3V.



14. A 5 cm^2Ge Solar cell with a dark reverse saturation current of 3 nA, producing 4 × 10^{17} electron- hole pairs per second when radiation is incident upon it. The electron - hole diffusion length may be assumed to be 4 μm . Calculate the short-circuit current and open-circuit voltage of cell.
15. You are given with three Voltage Sources 1.08V, 1.47V and 2V. How will you construct
    a) Unit gain summing amplifier and b) averaging circuit ?
16. Design a First order law pass filter having cut off frequency 3kHz.
17. Differentiate between synchronous and asynchronous counters? Explain how a mode 3 counter is working.
18. Draw the truth table of the system which has high outputs when the equivalent decimal inputs are 1,2,3,7,9,10,11 and 14 and low for all other inputs. Draw the Karnaugh map for the truth table and obtain the simplified Boolean equation of the system.
19. Derive the expression for notch filter.

(4 × 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **PHY2C05: QUANTUM MECHANICS-I**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			20 Hrs	**20 Hrs**	**15 Hrs**	**5 Hrs**	**12 Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	**1**	**1**	1				
		2	1				
		3		1			
		4		1			
		5			1		
		6			1		
		7					1
		8					1
II	**5**	**9**	1				
		10		1			
		11			1		
		12					1
III	**3**	**13**	1				
		14	1				
		15		1			
		16			1		
		17				1	
		18				1	
		19					1
Actual Weightage >> >>			**13**	**10**	**10**	**6**	**10**

M.Sc. Physics/2020 Admission onwards

Name: ………………………

Reg. No……………………...

ST. THOMAS' COLLEGE (AUTONOMOUS), THRISSUR
SECOND SEMESTER M.Sc. DEGREE EXAMINATION………..

PHY2 C05: Quantum Mechanics – I

Time: Three Hours Maximum: 30 Weightage

Part A

(*Answer **all** questions. Each question has **1** weightage*)

1. Define a linear vector space. Mention its properties.
2. What is momentum representation? Write down the position operator in momentum representation.
3. Which are the different pictures of time development in quantum mechanics?
4. State the properties of Pauli spin matrices.
5. Discuss the symmetries associated with the different conservation laws in physics.
6. Explain the principle of indistinguishability in quantum mechanics.
7. What is time reversal? What is its significance in physics?
8. Differentiate partial wave analysis from Born approximation in scattering theory.

(8 x 1 = 8 weightage)

Part B

(*Answer any **two** questions. Each question has **5**weightage*)

9. What are different pictures of quantum mechanics? Apply Schrodinger picture to study the linear harmonic oscillator.
10. Discuss the problem of addition of angular momentum in quantum mechanics. Calculate the Clebsh-Gordan coefficients for J1 = 1/2 and J2 = 1/2.
11. Establish the importance of the symmetry of the wave functions, taking the example of the ground state of helium atom.
12. Outline the method of partial wave analysis for low energy scattering.

(2 x 5 = 10 weightage)

Part C

(*Answer any* ***four*** *questions. Each question has* **3** *weightage*)

13. Prove the uncertainty relation for energy and time from position-momentum uncertainty relation.
14. Define a Hermitian operator. Show that the eigenvalues of a Hermitian operator are real.
15. (a) Show that if a particle is represented by a wavefunction Ψ = exp (ikz), the z-component of its angular momentum is zero.
    b) Show that the expectation values of Lx and Ly are zero for a system which is in an eigen state of Lz.
16. A beam of particles has a wave function $\Psi(x)$ = u(x) exp (ikx) where u(x) is a real function. Obtain the probability current density.
17. Show that the eigen values of hermitian operator are real. Also show that vectors belonging to different eigen values are orthogonal.
18. Prove Pauli exclusion principle for a system of fermions.
19. Obtain the expression for the scattering cross section for a beam scattered by a rigid sphere.

(4 x 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **: PHY2C06: MATHEMATICAL PHYSICS -II**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			15 Hrs	**20Hrs**	**14 Hrs**	**12Hrs**	**9Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
		2	1				
		3		1			
		4		1			
		5		1			
		6			1		
		7				1	
		8					1
II	5	**9**	1				
		10		1			
		11			1		
		12				1	
III	3	**13**	1				
		14	1				
		15		1			
		16			1		
		17				1	
		18					1
		19					1
Actual Weightage >> >>			**13**	**11**	**9**	**9**	**7**

M.Sc. Physics/2020 Admission onwards

Name……………………………

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ST. THOMAS' COLLEGE,(AUTONOMOUS), THRISSUR
SECOND SEMESTER M.Sc. DEGREE EXAMINATION…………………

PHY 2C 06 – Mathematical Physics -II

Time :3 Hours Maximum : 30 Weightage

Part A

Answer ***all*** questions
Each question carries 1 weightage.

1. Define 'pole' and 'residue' of a complex function.
2. Which of the following are analytic functions of complex variable?
   a) $|z|$ b) z^{-1}
3. What are the properties of Lie group?
4. Define permutation group and alternating group.
5. Give an account of SU(3) groups.
6. Explain the classes of integral equations.
7. What are the advantages of using Greens function technique in solving boundary value problems?
8. Assuming the Euler's equation for $f(x,y,y_x)$, where $y_x = \frac{dy}{dx}$, evaluate $\frac{df}{dx} - \frac{d}{dx}(f - y_x \frac{\partial f}{\partial y_x})$.

(8 × 1 = 8 weightage)

Part B

Answer any ***two*** questions.
Each question carries 5 weightage.

9. Expand $f(Z) = \frac{1}{(z+1)(z+3)}$ as a Laurent's series valid for
   (i) $|z|<1$ (ii) $1<|z|<3$.
10. Explain homomorphism of the groups SO(2) and SU(3).
11. A particle, mass m, is on a frictionless horizontal surface. It is constrained to move so that $\theta = \omega t$ (rotating radial arm, no friction). With the initial conditions t=0, $r=r_0$, $\dot{r}=0$,
    (a) Find the radial positions as a function of time.
    (b) Find the force exerted on the particle by the constraint.
12. Formulate the Greens function for Sturm-Liouvelle differential operator in one dimension.

(2× 5 = 10 weightage)

Part C

Answer any ***four*** questions.
Each question carries 3 weightage.

13. Find the value of the integral $\int_c \frac{e^z dz}{(z-1)(z+3)^2}$ where C is given by

    (a) $|z|$=3/2 (b) $|z| = 10$

14. Find the poles and residues at the poles for the following functions.

    (a) $\frac{z}{\cos z}$ (b) $\frac{ze^z}{(z-a)^3}$

15. Show that matrices $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}, \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}, \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ form a group under matrix multiplication.

16. Obtain the integral equation corresponding to the boundary value problem $y''(x) + \lambda y(x) = 0$ with y(0) = y(1) = 0.

17. For a vibrating string clamped at both ends $y''(x) + \lambda y(x) = 0$. Find the solution of this differential equation using Greens functions.

18. Apply Euler equation to find the shortest distance between two points in Euclidean space.

19. Proof the symmetry of the Green's function.

(4× 3 =12 Weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **PHY2C07: STATISTICAL MECHANICS**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			13Hrs	**21Hrs**	**15 Hrs**	**10Hrs**	**13Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
		2	1				
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		7				1	
		8					1
II	5	**9**	1				
		10		1			
		11			1		
		12				1	
III	3	**13**	1				
		14		1			
		15		1			
		16			1		
		17				1	
		18					1
		19					1
Actual Weightage >> >>			**10**	**13**	**9**	**10**	**7**

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Name: ………………………

Reg. No……………………...

ST THOMAS' COLLEGE (AUTONOMOUS), THRISSUR

SECOND SEMESTER M.Sc. DEGREE EXAMINATION ………………

PHY2C07 – STATISTICAL MECHANICS

Time : 3 Hours Maximum : 30 Weightage

Part A

*Answer **all** questions.*
*Each question carries **1 weightage**.*

1. What is a phase space?
2. Explain the postulate of equal a priori probability.
3. How does the statistical approach provide a theoretical basis for third law of thermodynamics?
4. Differentiate between macrostate and microstate.
5. What is meant by chemical potential?
6. What is the difference between Π and Ω in the case of microstates?
7. What is partition function?
8. Explain the use of density matrix.

(8 ×1 = 8 weightage)

Part B

*Answer any **two** questions.*
*Each question carries **5 weightage**.*

9. What is Gibb's Paradox? Derive the SackurTetrode equation for entropy.
10. State and explain Liouville's theorem. What are its consequences?
11. Discuss the Pauli paramgnetism using classical and quantum theory.
12. Discuss Bose – Einstein condensation.

(2 × 5 = 10 weightage)

Part C

*Answer any **four** questions.*

*Each question carries **3 weightage**.*

13. Derive the equation for chemical potential and determine it is intensive or extensive.
14. Show that the pressure of a system of non-relativistic, non-interacting particles is two thirds of its energy density
15. Show that PV^{γ} = constant for a reversible adiabatic system.

16. Show that the fundamental volume must be in the nature of an " angular momentum raised to the power 3N" by taking the example of classical ideal gas.
17. State and explain the equipartition theorem.
18. Obtain the expression for the entropy of classical ideal gas by canonical ensemble formulation.
19. Discuss the phase space trajectory of a one dimensional simple harmonic oscillator.

(4 × 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **PHY2C08 : COMPUTATIONAL PHYSICS**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			12Hrs	**12 Hrs**	**12 Hrs**	**12Hrs**	**`12Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
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		7				1	
		8					1
II	5	**9**	1				
		10		1			
		11			1		
		12					1
III	3	**13**	1				
		14		1			
		15			1		
		16				1	
		17				1	
		18				1	
		19					1
Actual Weightage >> >>			**10**	**10**	**10**	**10**	**9**

M.Sc. Physics/2020 Admission onwards

Name: ………………………

Reg. No……………………...

ST. THOMAS COLLEGE (AUTONOMOUS), THRISSUR

SECONDSEMESTERM.Sc. DEGREEEXAMINATION……………..

PHY2C08-COMPUTATIONALPHYSICS

Time:3hours   Maximum:30Weightage

SectionA

*Answer**all**questions. Eachquestionhasweightageof1.*

1. Explain the read and write operations in a file.
2. Compare between lists and dictionaries in Python.
3. Explain the concept of difference table with an example.
4. What are the advantages of relaxation method over shooting method?
5. What is meant by parametric plots? How parametric plots are created using Python?
6. How cross product and dot products are calculated in Python. Explain with suitable examples.
7. Explain the Numerov's method.
8. Define FFT. Why is FFT called so?

(8x1=8weightage)

SectionB

*Answerany**two**questions.Eachquestionhasweightageof5.*

9. With suitable examples, explain the concepts of classes, methods and inheritance in object oriented programming of Python.
10. Explain the process of numerical integration for a given function using trapezoidal rule and Simpson's one-third rule.
11. Write a program to trace the path of projectile considering the variation of gravity and air drag. Use Euler's method.
12. Explain Monte Carlo method to calculate integrals. Write Python programs to (i) evaluate value of π (ii) simulate radioactive decay.

(2x 5=10weightage)

SectionC

*Answerany**four**questions.Eachquestionhasweightageof3.*

13. Write a program to plot *t* graph of simple harmonic oscillator.
14. Writeapythonprogramusing*linalg*moduletosolvetheequations by inputting the equations

$$4x + 7y - 4z = 6$$
$$5x - 3y - 3z = 7$$
$$3x - 3y + 2z = 5$$

15.Writeapythonprogramtosimulate the gamma function.
16. By the method of least squares, find the best fitting straight line from the following data.

x	2	4	6	8	10	12	14
y	9.4	15.1	16.2	23.3	25.4	28.4	34

17. Using 4^{th} order RungeKutta method, find y(1.2) for $dy/dx = -4x^2y$, $y(0) = 1$ with step length 0.4. Also compare the solution obtained with RungeKutta method of order two.
18. Write a python program to find the count of prime numbers in a given range.
19. Discuss a Python program for obtaining the bifurcation diagram of logistic map.

(4x3=12weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:**PHY3C09: QUANTUM MECHANICS - II**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			20Hrs	**12Hrs**	**12 Hrs**	**12Hrs**	**16Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
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		8					1
II	5	**9**	1				
		10			1		
		11				1	
		12					1
III	3	**13**	1				
		14		1			
		15		1			
		16			1		
		17				1	
		18					1
		19					1
Actual Weightage >> >>			**10**	**8**	**9**	**9**	**13**

Name.………………………………
Reg. No……………………………

ST THOMAS' COLLEGE (AUTONOMOUS), THRISSUR

THIRD SEMESTER M.Sc. DEGREE EXAMINATION………………..

PHY3C09- QUANTUM MECHANICS II

Time: Three Hours Maximum Weightage: 30

Section A

Answer **all** *questions*

Each question carries **one** *weightage*

1. State and explain Fermi's golden rule for transition to a continuum.
2. What is the procedure of quantization of fields? Why is it called second quantization?
3. Explain the principle of variational method in quantum mechanics.
4. Obtain the validity condition for WKB approximation.
5. State the anti commutation relations among the creation and annihilation operators for a system of Fermions.
6. Explain the criterion for dipole approximation.
7. In what elegant way did Dirac bring about Lorentz covariance to the Schrodinger equation?
8. Explain the Hole theory of Dirac equation.

(8 x 1 = 8 weightage)

Section B

Answer **any two** *questions*

Each question carries ***five*** *weightage*

9. Estimate the ground state energy of Helium atom by variational method.
10. Discuss in detail the method of time independent perturbation theory and obtain the first order correction for energy eigen values for a non degenerate case.
11. Show that the Dirac theory endows an electron with a magnetic moment of one Bohr magneton.
12. Obtain the classical field equation in terms of the Lagrangian density.

(2 x 5 = 10 weightage)

Section C

Answer **any four** *questions*

Each question carries **three** *weightage*

13. If the Lagrangian density of a fermion is given by $L = \bar{\psi}\,(\gamma_\mu \partial_\mu + m)\psi + \alpha\left|\bar{\psi}\,\psi\right|^2$, derive its Hamiltonian density.
14. Bohr Sommerfeld quantization rule is a natural consequence of WKB approximation. Justify.

15. Obtain the energy eigen values of an anharmonic oscillator.
16. Show that Klein Gordon equation can lead to negative probability density.
17. Estimate the ground state energy of a particle in a potential $V(r) = -V_0 e^{-\alpha r}$ using variational method and trial wave function proportional to e^{-br}.
18. Find the first order correction to energy and wave function to one dimensional harmonic oscillator ground state when a perturbing potential $e^{-\alpha x}$ is applied to it.
19. Obtain the Weyl equations of the neutrino.

(4 x 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **PHY3C10: NUCLEAR AND PARTICLE PHYSICS**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			12 Hrs	**12 Hrs**	**19 Hrs**	**12Hrs**	**17Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
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II	5	**9**	1				
		10		1			
		11			1		
		12					1
III	3	**13**	1				
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		15			1		
		16			1		
		17				1	
		18					1
		19					1
Actual Weightage >> >>			**9**	**10**	**13**	**5**	**12**

M.Sc. Physics/2020 Admission onwards

Name……………………………..…

Reg. No……………………..………

ST.THOMAS' COLLEGE (AUTONOMOUS), THRISSUR.

THIRD SEMESTER M.Sc. DEGREE EXAMINATION,……………

PHY3C10-NUCLEAR AND PARTICLE PHYSICS

Time: 3 hours Maximum: 30 weightage

Section A.

(Answer all, each carries weightage 1.)

1. What is the significance of deuteron problem?
2. Explain the reasons for the introduction of liquid drop model of nucleus.
3. Explain electric quadruple moment.
4. Explain significance TCP theorem in beta decay.
5. Differentiate electron capture and internal conversion.
6. What is meant by spontaneous fission?
7. Differentiate between single channel and multichannel analyzer.
8. Explain quantum gravity.

Total weightage 8X1=8

Section B.

(Answer any two, each carries weightage 5.)

9. Derive the effective range theory uisng n – p scattering.
10. Using shell model theory, explain the energy levels of nucleons.
11. Explain the Fermi theory of beta decay.
12. Discuss the symmetry and conservation laws in elementary physics.

Total weightage 2X5=10

Section C.

(Answer any four, each carries weightage 3.)

13. Predict the angular momentum and parities for the ground state of ^{14}N, and ^{17}O using Shell Model.
14. Compute the total binding energy and binding energy per nucleon for ^{17}O and ^{235}U.
15. Calculate the threshold energy required to initiate the reaction $^{31}P(n,p)^{31}Si$. Calculate also the maximum energy of β decay of ^{31} Si to ^{31} P. Given M_n=1.00898 amu, M_p=1.00814 amu , M(P)=30.983556 amu and M(Si)=30.98515 amu.
16. The mean lives of a radioactive substance are 1620 years and 405 years for alpha and beta emissions respectively. Find the time during which three fourth of the sample will decay by alpha and beta emissions simultaneously.
17. Discuss the following reactions:
    (a) $k^- + p \rightarrow \Omega^- + k^+ + K^0$ (b) $\pi^- + p \rightarrow \Sigma^+ + K^-$

18. Check the validity of the reaction
    (a) $\pi^- + \Omega^- \rightarrow \lambda^0 + \pi^0$ (b) $p + p \rightarrow p + \pi^0 + K^+$
19. Determine the quark composites of the following: $\sum^+$, Ξ^-, Ω^-

Total weightage 4X3=12

Blue Print for Question Paper Setting / Scrutiny (QP-A)								
PG Programme : PHYSICS								
Course and course code:: **PHY3C11: SOLID STATE PHYSICS**								
Total Mark: 30 Weightage								
Question Paper			**Syllabus**					
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**	**UNIT 6**
			12Hrs	**8 Hrs**	**15 Hrs**	**20 Hrs**	**10 Hrs**	**7 Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>								
I	1	**1**	1					
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II	5	**9**		1				
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		12					1	
III	3	**13**	1					
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		15			1			
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		18				1		
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Actual Weightage >> >>			**8**	**6**	**11**	**13**	**9**	**2**

Name……………………………..…
Reg. No…………………..………..

ST.THOMAS' COLLEGE (AUTONOMOUS), THRISSUR.
THIRD SEMESTER M.Sc. DEGREE EXAMINATION,……………

PHY3 C11: Solid State Physics

Time: 3 hrs Maximum: 30 weightage

Section A.
(Answer all, each carries weightage 1.)

1. What do you mean by Brillouin zones? What is the importance of Brillouin zones?
2. State the difference between Einstein and Debye model of specific heat in crystalline solids.
3. Calculate the atomic packing fraction of FCC lattice.
4. Explain the concept of effective mass of charge carriers.
5. Write a short note on BCS theory of superconductivity.
6. Differentiate between type I and type II superconductors.
7. Write a short note on Ferro Magnetic domains.
8. Write a short note on Lorentz field.

Total weightage 8X1=8

Section B.
(Answer any two, each carries weightage 5.)

9. (a) What do you mean by reciprocal lattice and explain its significance?
   (b) Derive the Braggs diffraction condition in terms of the reciprocal lattice vector **G**.
   (c) Show that the reciprocal lattice corresponding to BCC is an FCC and vice versa.
10. How will you account for the field penetration in thin film superconductors using London equations?
11. Derive an expression for susceptibility of a paramagnetic material using classical approach.
12. Why classical model fails to explain the electronic specific heat capacity of metals and hence derive an expression for the same using Fermi-Dirac distribution function?

Total weightage 2X5=10

Section C.
(Answer any four, each carries weightage 3.)

13. Lattice constant of unit cell of α-iron is 0.287 A^0. Find the number of atoms per mm2 of planes (100), (110) and (111) if structure of alpha iron is BCC.

14. The energy near the valence band edge of a crystal is given by E = -Ak^2, A = 10^{-39}Jm^2. An electron with wave vector k = 10^{10} kx m^{-1} is removed from an orbital in the completely filled valence band. Determine the effective mass, velocity, momentum and Energy of the hole.
15. Cu has density of 8.95 x 10^3kg/$m^3$and an electrical conductivity 6.4 x 10^7 $0hm^{-1}m^{-1}$m-1 at room temperature. Calculate the mean free time, Fermi energy, Fermi velocity and mean free path at Fermi level. Atomic Wt. of Cu is 63.54.
16. At what temperature the electronic and lattice specific heats of Cu will be equal? E_f = 7 eV and θ_D= 348 K.
17. . Calculate the frequency of radiation which must be incident on a substance placed in a magnetic field of strength 5 x $10^5/\pi$ Amp/m, so that the electron can absorb energy
18. . Calculate the London penetration depth λ0 at 0 K for Pb whose density is 11.3 x 10^3kg/$m^3$and atomic wt. 207.19. Its T_c= 7.22 K. Calculate the increase in λ at 3.61 K from its value at 0 K.
19. A paramagnetic material is subjected to a homogeneous field of 106 ampere/metre at 370°C. Calculate the average magnetic moment along the field direction per spin Bohr magneton.

Total weightage 4X3=12

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Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:: **PHY3E05: EXPERIMENTAL TECHNIQUES (ELECTIVE-I)**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			19Hrs	**14 Hrs**	**14 Hrs**	**15 Hrs**	**10Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
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		8					1
II	5	**9**	1				
		10		1			
		11			1		
		12				1	
III	3	**13**	1				
		14	1				
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		17				1	
		18				1	
		19					1
Actual Weightage >> >>			**13**	**9**	**9**	**13**	**5**

Name……………………………..…
Reg. No……………………..……..

ST.THOMAS' COLLEGE (AUTONOMOUS), THRISSUR.
THIRD SEMESTER M.Sc. DEGREE EXAMINATION,……………
PHY3E05: EXPERIMENTAL TECHNIQUES

Time : 3 Hours **Total weightage : 30**

Section A
(Answer ALL questions , each carry weightage 1)

1) Explain the principle of a Pirani ionization gauge
2) Give the principle of thin film preparation by Electron Beam evaporation.
3) What are the advantage of rf acceleration over electrostatic acceleration?
4) Write down and explain the Scherrer equation
5) How thin targets are prepared for PIXE measurements?
6) Briefly explain the principle of phase stability in synchro cyclotron
7) Why backing pump is necessary for diffusion pump?
8) Give the principle of thin film preparation by the sputtering techniques

Total weightage (8×1 = 8)

SECTION B
(Answer ANY TWO questions , each carry weightage 5)

9) What are different types of Vacuum Pumps ?. With the help of diagram, explain the various parts and working of Turbo molecular pump and its advantages ?.
10) Explain the principle of Interference method for determining the thickness of thin film. Derive the relevant equation also describe the experimental set up with the help of a diagram
11) Discuss the theory behind Diffractometer. Explain its instrumentation and various applications
12) Describe the principle of the Rutherford Backscattering. Give the experimental set up. Application of Rutherford backscattering.

Total weightage (2×5 = 10)

SECTION C
(Answer ANY FOUR questions, each carries weightage 3)

13) A Chamber of volume 2000 l is to be pumped by diffusion pump based system of effective pumping speed 21 l/s from 10^{-3} to 10^{-7}torr. The ultimate pressure of the pump is 8×10^{-7}torr calculate the pump down time

14) For an electron and proton moving along circles in a uniform magnetic field B=10 KG determine the orbital periods and radii if the kinetic energy of the particles is 10 MeV. Also ,find the kinetic energies if the orbital radius is 10 cm

15) What is the time variation function $\omega(t)$ of the frequency of a Synchro cyclotron , if the magnetic field flux density is B and the mean free energy acquired by a particle per revolution is ε .

16) In vacuum evaporation unit the substrate kept at a distance of 20 cm from the heating boat.1 g of certain material is evaporated completely in the boat. Find the thickness of the film deposited . The thin film is used in an interferometer for thickness measurement .If the wavelength of light used is 4358 A^o, Calculate the shift in the fringes . Assume μ=1.5

17) The calibration constant K for a particular trace element using the PIXE set up was 2548 counts/µgm/µ C . For the internal standard element used with a concentration of 100 ppm the corresponding value is 515. Evaluate the concentration of the trace element considered .

18) An alpha particle with a momentum 53 MeV/c is scattered at an angle 60^0 by the coulomb field of a stationary uranium nucleus (A=238) find the impact parameters .

19) The pressure in a gas thermometre is 0.70 atm. at 100^0C and 0.512 atm at 0^0C.

(a) What is the temperature when the pressure is 0.04 atm?

(b) What is the pressure at 450^0C ?

Total weightage (4×3 = 12)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:**PHY4C12: ATOMIC AND MOLECULAR SPECTROSCOPY**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			18Hrs	**18Hrs**	**14 Hrs**	**10Hrs**	**12Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
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II	5	**9**	1				
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		12					1
III	3	**13**	1				
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		17			1		
		18				1	
		19					1
Actual Weightage >> >>			**10**	**12**	**8**	**9**	**10**

Name………………………………

Reg. No……………………………

ST.THOMAS' COLLEGE (AUTONOMOUS), THRISSUR.

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION,……………

PHY4C12: ATOMIC AND MOLECULAR SPECTROSCOPY

Time : Three Hours Maximum : 30 Weightage

Part A

*Answer **all** questions.*
*Each question carries **a** weightage of **one***

1. Briefly explain different coupling schemes in an atom.
2. Draw a Space quantization diagram for d electrons in a strong magnetic field.
3. Diatomic molecules do not show vibrational spectra. Justify the statement.
4. Explain Inverse Raman scattering.
5. Write a note on Franck-Condon principle.
6. Explain progressions and sequences.
7. Explain the principle of ESR.
8. Explain isomer shift with an example.

(8 × 1 = 8 weightage)

Part B

*Answer **any two** questions.*
*Each question carries a weightage of **five***

9. Derive an expression for Lande's splitting factor and explain the anomalous Zeeman effect of sodium doublet lines D1 and D2 with its help.
10. Describe the construction and working of a microwave spectrometer.
11. Explain how the structure of XY_2 type and XY_3 type is determined using Raman and I.R. spectroscopy.
12. Explain the different relaxation pricesses for nuclei and derive Bloch equations.

(2 × 5 = 10 weightage)

Part C

*Answer any **four** questions.*
*Each question carries a weightage of **three***

13. Show that the Lande g-factor for pure orbital angular momentum and pure spin angular momentum are respectively 1 and 2. Also, evaluate the g-factor for the state $^3P_1$.

14. Rotational and centrifugal constant of HCl molecule are $10.593\, cm^{-1}$ and $5.3 \times 10^{-4} cm^{-1}$. Estimate the vibrational frequency and force constant of the molecule.
15. Calculate the energy in cm^{-1} of photon absorbed when NO molecule goes from the state $V = 0,\ J'' = 0$ to $V = 1,\ J' = 1$. Assume $\overline{\nu_e} = 1904\ cm^{-1}$, $h = 6.625 \times 10^{-34}$ JS , $x_e = 0.00733$, $r_{NO} = 0.1151\, nm$, $\mu = 12.3975 \times 10^{-27}$Kg
16. Irradiation of CCl_4 by 4358 Å radiation gives Raman lines at 4400, 4419 and 4479 Å. Calculate the Raman shift for each of these lines.
17. A Raman line is observed at 4768.5 Å when acetylene was irradiated by 4358.3 Å radiations. Calculate the equilibrium vibrational frequency that causes this shift.
18. The band origin of a transition in C_2 is observed at 19378 cm^{-1}, while the rotational fine structure indicates that the rotational constants in excited and ground states are, respectively, $B' = 1.7527\, cm^{-1}$ and $B'' = 1.6326\, cm^{-1}$. Estimate the position of the band head. Which state has the larger internuclear distance?
19. A free electron is placed in a magnetic field of 2.6 T. calculate the resonant frequency. $g = 2.0023$, $\mu_B = 9.274 \times 10^{-24}$.

(4 × 3 = 12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:**PHY4E13: LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS (ELECTIVE-II)**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			18Hrs	**12Hrs**	**14 Hrs**	**13 Hrs**	**15Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
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II	5	**9**	1				
		10			1		
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		12					1
III	3	**13**	1				
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		19					1
Actual Weightage >> >>			**12**	**7**	**10**	**9**	**11**

M.Sc. Physics/2020 Admission onwards

Name…………………..………………

Reg. No…………..………………

ST.THOMAS' COLLEGE (AUTONOMOUS), THRISSUR.

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION,……………

PHY 4 E 13 – LASERS AND FIBRE OPTICS

Time : Three Hours | Maximum : 30 Weightage

Part A

*Answer **all** questions.*
*Each question carries **1***weightage.

1. What is mode locking?
2. Explain semiconducting lasers.
3. Discuss Optical parametric Oscillator
4. Explain energy level diagram of lasing action in He-Ne laser
5 Briefly discuss working principle of ruby laser
6. Distinguish between saturable absorption, reverse saturable absorption.
7. Discuss thermal nonlinear optical effects.
8. Write short note on laser induced fission?

(8×1 = 8 weightage)

Part B

*Answer any **two** questions.*
Each question carries 5 weightage.

9. What are Einstein coefficients? How it affects transition probability and population inversion in lasers?
10. Explain second and third Harmonic generation. Discuss symmetry requirement for second Harmonic generation.
11. Describe the spatial frequency filtering. Explain the principle of holography.
12. Discuss the various attenuation losses in fibers. Explain each

(2×5= 10 weightage)

Part C

*Answer any **four** questions.*
*Each question carries **3***weightage.

13. Find the ratio of populations in the two states in He-Ne laser that produces light of wavelength 6328 A^0 at 27^0 C.
14. Calculate the gap in frequency between two longitudinal modes in a linear cavity whose optic length, L, =300 mm.

15. Monochromatic light of wavelength 632.8 nm is produced by a helium-neon laser. The power emitted is 9.42 mW. How many photons per second, on the average, arrive at a target irradiated by this beam?

16. Determine the coherence length for second harmonic generation in KDP when subjected to pulsed ruby laser light at λ= 694 nm. Appropriate refractive indices are n(694) = 1.505 and n(347) = 1.534

17 Explain fundamental principle of a hologram. How is it produced and how is the image constructed from it?

18. Optical power of 0.5mW is launched into an optical fiber of length 100m. If the power emerging from the other end is 0.3mW, calculate the fiber attenuation.

19. The optical power after propagating a distance of 500 m through a fiber is reduced to 40% of its original value. Calculate the fiber loss in dB/km.

(4×3=12 weightage)

Blue Print for Question Paper Setting / Scrutiny (QP-A)							
PG Programme : PHYSICS							
Course and course code:**PHY4E20: MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS(ELECTIVE – III)**							
Total Mark: 30 Weightage							
Question Paper			**Syllabus**				
Sections or Parts	Weightage	Question Numbers	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**	**UNIT 5**
			12Hrs	**10 Hrs**	**16 Hrs**	**16Hrs**	**18Hrs**
			Weightage	**Weightage**	**Weightage**	**Weightage**	**Weightage**
Expected Weightage >>>>							
I	1	**1**	1				
		2		1			
		3		1			
		4			1		
		5			1		
		6				1	
		7				1	
		8					1
II	5	**9**	1				
		10			1		
		11				1	
		12					1
III	3	**13**	1				
		14		1			
		15			1		
		16			1		
		17				1	
		18				1	
		19					1
Actual Weightage >> >>			**9**	**5**	**13**	**13**	**9**

M.Sc. Physics/2020 Admission onwards

Name………………………………

Reg. No……………………………

ST.THOMAS' COLLEGE (AUTONOMOUS), THRISSUR.
FOURTH SEMESTER M.Sc. DEGREE EXAMINATION,……………
PHY4E20: MICROPROCESSORS AND APPLICATIONS

Time: 3hrs Maximum: 30 weightage

Section A.

(Answer all, each carries weightage 1.)

1. Write a note on the registers of 8085.
2. Discuss the arithmetic and logic operations of 8085.
3. Explain the functions of stack pointer.
4. Discuss the functions of timing and control unit of 8085.
5. Write short note on DMA.
6. What is meant by serial data transfer scheme?
7. Distinguish between RAM and ROM in AVR.
8. What do you understand by bit addressability in AVR?

Total weightage 8X1=8

Section B.

(Answer any two, each carries weightage 5.)

9. Discuss the architecture of 8085 with a neat diagram.
10. Describe the different data transfer schemes of 8085.
11. Explain the 7 segment LED displays and its interfacing to 8085.
12. Explain theI/O ports of AVR and their functions.

Total weightage 2X5=10

Section C.

(Answer any four, each carries weightage 3.)

13. Write a program to find the largest of 10 numbers using 8085.
14. Draw the timing diagram for MVI r,data.
15. Calculate the time delay that can be achieved using 3 register subroutine.
16. Calculate the digital value corresponding to a) 256 b) 10 c) 67 using A/D converter.
17. Discuss the delay and call loops in AVR using suitable examples.
18. Write a program to create a square wave of 50% duty cycle on bit 0 of port C.
19. Write an AVR C program to toggle all the bits of port B 200 times.

Total weightage 4X3=12