ORDINANCES
AND
OUTLINES OF TESTS,
SYLLABI AND COURSES OF READING
FOR
M.Sc. (PHYSICS)
(2021-22)
COURSE CODE: MPHY

GENERAL SHIVDEV SINGH DIWAN GURBACHAN SINGH

KHALSA COLLEGE PATIALA

An Autonomous College
NAAC Accredited 'A' Grade
College with Potential for Excellence Status by UGC,
Star College Status-DBT
E-mail: Khalsacollegepatiala@gmail.com
Website: www.khalsacollegepatiala.org

APPROVED
Member Secretary
Academic Council

APPROVED
Principal
General Shivdev Singh Diwan Gurbachan Singh
Khalsa College Patiala

Preamble:

General Shivdev Singh Diwan Gurbachan Singh Khalsa College Patiala, accredited 'A' grade by NAAC (2015), recognized as "College with Potential for Excellence" status by UGC, New Delhi (2016) and an Autonomous College (2016), is a premier institute of higher education in the state of Punjab since 1960. Being concordant with the need to the creation of a self-sustaining, global knowledge society, the college has undertaken several measures initiated by UGC to bring equity, efficiency and excellence in the Higher Education System of the country.

The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by Higher Educational Institutions towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching–learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students. Presently, the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades.

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So, it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated CBSS guidelines.

DEFINITIONS

a. **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
b. **Course:** Usually referred to, as ‘papers’ is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/tutorials/laboratory work/field work/outreach

activities/ project work/vocational training/viva/seminars/term papers /assignments/ presentations/self study etc. or a combination of some of these.

c. **Credit Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.

d. **Credit Point (CP):** The numerical value obtained by multiplying the grade point (GP) by the no. of credits (C) of the respective course i.e. CP= GP X C.

e. **Credit (C):** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week, i.e. a course with assigned L-T-P: 3-0-2 or 3-1-0 will be equivalent to 4 credits weight-age course.

f. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

g. **Grade Point (GP):** It is a numerical weight allotted to each letter grade on a 10 point scale.

h. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.

i. **Programme:** An educational programme leading to award of a degree, diploma or certificate.

j. **Semester Grade point Average (SGPA):** It is a measure of performance of work done in a semester. It is ratio of total credit points (CPs) secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed upto two decimal places.

k. **Semester:** Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to December and even semester from January to June.

l. **Transcript or Grade Card (GC) or Certificate:** Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, no. of credits, grades secured) along with SGPA of that semester and CGPA earned till date semester.

m. **Semester Examinations:** The comprehensive examinations conducted for summative evaluation of course. The duration of these examinations shall be 3 hours for both theory and practical courses and the weight shall be as per the ordinance of relevant programme.

n. **L-T-P:** The prescribed hours/week during a semester for Lecture-Tutorial-Practical to a particular course, in accordance with curriculum prescriptions based on respective nature.

ORDINANCES FOR M.Sc. PHYSICS

Applicability of Ordinances for the time being in force.

Notwithstanding the integrated nature of a course spread over more than one academic year, the Ordinances in force at the time a student joins a course shall hold good only for the examination held during or at the end of the academic year. Nothing in these Ordinances shall be deemed to debar the College from amending the ordinances subsequently and the amended ordinances, if any, shall apply to all the students whether old or new.

1. The examination for the degree of Master of Physics shall be held in two parts to be called M.Sc Part-I and M.Sc Part-II. Each part shall consist of two semesters, viz. Semester 1st and 2nd in Part –I and semester 3rd and 4th in Part-II. The examination shall be held in the months of November/December for 1st and 3rd semester and April /May for 2nd and 4th semester or on such other dates as may be fixed by the Institute.
2. a) The M.Sc Part-I shall be open to a candidate who has passed B.Sc (NM/CA), B.Sc. (Hons) Physics examinations with at least 50% marks in the aggregate from any university or any other examination recognized as equivalent thereto.
   b) 5% additional weightage will be given to B.Sc. (Honours) Physics students for admission in M.Sc. (Physics) Part I.
3. M.Sc Part- II shall be open to any person who has passed M.Sc Part- I examination or has cleared at least 50% of total papers prescribed for first and second semesters of M.Sc courses. In case, the result of 2nd semester is not declared at the time of admission to 3rd semester, the student may be admitted provisionally and will be allowed to take the examination of 3rd semester if he/she has passed 50% of the total papers of first year (i.e. 1st and 2nd semester).
4. A candidate must complete and pass the whole course of two years within a maximum of four years from the date of admission in M.Sc First semester. If the candidate does not clear the lower examination within stipulated period the higher result of the candidate will stand automatically cancelled.
5. Semester examinations will be open to regular candidates who have been on the rolls of the college and meet the attendance and other requirements as prescribed in the ordinances of the course.
6. **Examination Rules**

   Paper Setting/Evaluation will be done by an External Examiner or as decided by the Examination Cell.

   The supplementary examination will be held along with the routine End Semester Tests. The supplementary paper would be from the syllabi prescribed for that session in which the candidate is appearing. The student can appear in the theory/practical paper on the payment of the required fee. The candidate will have consecutive two attempts to clear the Supplementary Examination; marks of practical and internal assessment will be carry forward as original.

Re-evaluation of answer sheet in two subjects is allowed after paying the requisite fee. The application for Re-evaluation should be submitted within 15 days of the declaration of the results. In case there is a difference of more than 10 % between the marking of the First evaluator and the Second evaluator, then the paper would be sent to a Third Evaluator. The mean of the marks of the Second and Third evaluators is then considered as the final marks. The re-evaluated marks will be considered final irrespective of the increase or decrease in marks.

The students who have reappear in the IIIrd semester only in Two Year Degree Course at the Postgraduate Level will be allowed to appear in their Reappear examination along with the Final Semester Examinations of their respective courses.

A Candidate placed under reappear in any paper, will be allowed two chances to clear the reappear, which should be availed within consecutive two year/chances i.e. to pass in a paper the candidate will have a total of three chances, one as regular student and two as reappear candidate.

The examination of reappear papers of odd semester will be held with regular examination of the odd semester and reappear examination in even semester with the even semester. But if a candidate is placed under reappear in the last semester of the course, he/she will be provided chance to pass the reappear with the examination of the next semester, provided his/her reappear of lower semester does not go beyond next semester.

The Principal can provide Golden Chance (with special chance fee) to students who have been unable to clear their exams even after two attempts.

Viva- voce/Practical examination shall be conducted by a committee consisting of the following:-

1. One external experts
2. One internal examiner (to be nominated by the Principal of the College/Head of the Department OR his/her nominee).

The quorum of Committee meeting would comprise one external and one internal examiner.

7. **IMPROVEMENT EXAMINATIONS:**

I. A student who has been declared 'pass' in the Postgraduate course he/she was admitted to, may apply for improvement examination within a year from the declaration of the result of the final semester and he/she can take maximum of 50% of the total papers for that course for improvement.

II. A student shall have to appear in End semester examination of the paper chosen for improvement along with the regular students. No special exam shall be held for him/her.

III. If a student fails to improve upon the original marks obtained in the paper chosen for improvement, his/her original marks shall be retained and he/she shall not get a second chance for improvement.

IV. Improvement examination in practical/MST paper shall not be allowed.

V. A student taking improvement examination shall have to pay a fee decided by the college.

8 **Grading System:**

The grades and their description, along with equivalent numerical grade points are listed in the Grading Assignment Table as follows:

Grade Assignment Table

Range of Marks	Description	Grade	Grade Point
91-100	Outstanding	O	10
81-90	Excellent	A+	9
71-80	Very Good	A	8
61-70	Good	B+	7
51-60	Above Average	B	6
41-50	Average	C	5
35-40	Pass/Fair	P	4
0-34	Fail	F	0
Otherwise	Absent/Detained	Ab/D	0

a. A student obtaining Grade F shall be considered failed and will be required to reappear in the examination.

b. For non credit courses **'Satisfactory' or 'Unsatisfactory'** shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

9. **Computation of SGPA and CGPA**

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

a. 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 undergone by a student, i.e.

SGPA (Si) = ∑(Earned Credits Ci x Grade Point Gi)/∑Earned Credits Ci;

Where Ci is the number of credits of the ith course and Gi is the Grade Point Scored by the student in the ith course.

b. 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, i.e.

CGPA (Ci) = ∑(Earned Credits Ci x SGPA Si)/∑Ci);

Where Si is the SGPA of the ith semesters and Ci is the total number of credits in that semester.

c. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration of the computation of SGPA and CGPA and Format for Transcripts

i. **Computation of SGPA and CGPA**

Illustration for SGPA

Course	Credits	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	3	A	8	3 X 8 = 24
Course 2	4	B+	7	4 X 7 = 28
Course 3	3	B	6	3 X 6 = 18
Course 4	3	O	10	3 X 10 = 30
Course 5	3	C	5	3 X 5 = 15
Course 6	4	B	6	4 X 6 = 24
	20			139

Thus, **SGPA = 139/20 = 6.95**

Illustration for CGPA

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
Credit : 20 SGPA : 6.9	Credit : 22 SGPA : 7.8	Credit : 25 SGPA : 5.6	Credit : 26 SGPA : 6.0
Semester 5	**Semester 6**		
Credit : 26 SGPA : 6.3	Credit : 25 SGPA : 8.0		

Thus, **CGPA** = $\frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144} = 6.73$

ii. Transcripts (Format):

Based on the above recommendations on Letter grades, grade points, SGPA and CGPA, the College may issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

10. **Division and Position:**

Division shall be awarded in the following manner, to the candidates on the basis of their respective CGPA:

CGPA 7.5 or more	1st Division with Distinction
CGPA 6.0 or more but less than 7.5	1st Division
CGPA 5.0 or more but less than 6.0	2nd Division
CGPA 3.5 or more but less than 5.0	3rd Division
Otherwise	Fail

However, First, Second or Third position shall be awarded to the candidates, provided they meet the following conditions:

a) Rank shall be solely decided on the final CGPA, on completion of degree credit requirement.

b) The candidate has completed all the prescribed requirements, in the prescribed programme duration.

c) The candidate has passed / secured valid grades in all the prescribed courses, in the first attempt.

d) No disciplinary action is pending or has ever been lodged against him/her.

e) In case of an exceptional tie, both candidates shall be awarded the same rank.

11. **Grade Card:**

At the end of each semester, a student will be given a 'Grade Card' which will contain Course Code, Title, Credits, Grades Awarded, Earned Credits and Earned Point secured by him/her in each course, together with his/her SGPA in that semester. On the completion of the programme, a Final Grade Card will be issued to the student, giving full semester-wise details about the absolute marks and grades obtained by him/her in each course together with his/her SGPA and also the CGPA and Division awarded to him/her.

12 **Equivalence:**

Percentage (P) equivalent to CGPA earned by a candidate may be calculated using the following formula:

P= CGPA X 10

13 **MALPRACTICES/UNFAIR MEANS**

The following shall be deemed to be unfair means:

I. Leaving the Examination Hall without submitting the answer book to the invigilator or taking away, tearing off or otherwise disposing off the same or any part thereof.

II. Using abusive language in the examination hall or writing the same in the answer sheet.

III. Making an appeal to the evaluator through answer sheet.

IV. Possession by examinee or having access to books, notes, papers, mobile or any other electronic material which can prove to be helpful in the exam.

V. Any action on the part of candidate at an examination trying to get undue advantage in the performance at examinations or trying to help another, or derive the same.

VI. Impersonating for a candidate in the examination.

VII. Intimidating, threatening, manhandling, using violence, show of force in any form against any invigilator or any person on duty, creating disturbance to the smooth conduct of the examination.

VIII. Any other action which the Controller Examination / Chief Controller deem fit to be a case of UMC.

In case the student is found to have used any of the above Unfair means:

I. His/her answer book shall be seized and He/She will be given a new answer sheet.

II. Invigilator shall submit a detailed report along with the answer book of the student and the related material, if any, to the Centre Superintendent who will subsequently hand it over to Controller Examination.

III. Written statement to this effect shall be obtained from the student by the Centre Superintendent. In case the student refuses to do the same, the fact of refusal must be recorded.

IV. The student reported to have used unfair means shall be allowed to appear in the subsequent papers. However, no marks would be awarded for the paper in which unfair means were used.

V. The Principal shall refer the cases of malpractices in Mid Semester tests, House Tests and End Semester Examinations, to an Unfair Means Committee, constituted by him/her for the purpose. Such committee shall follow the approved scales of punishment. The Principal shall take necessary action, against the erring students based on the recommendations of the committee.

The involvement of the Staff, who are in charge of conducting examinations, evaluating examination papers and preparing/keeping records of documents relating to the examinations if involved in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and recommended for award of appropriate punishment after enquiry.

14. **Attendance Regulations & Condonation:**

A student shall be eligible to appear for end semester examinations, if he/she acquires a minimum of 75% of attendance in each subject.

Request to the Principal for Condonation of shortage of attendance after the recommendation of the HOD will be forwarded to Lecture Shortage Condonation Committee. The committee can finally condone the shortage in aggregate up to 15% on medical grounds in each semester.

Any student representing the Institute/ University/ State/ Nation in any Academic/ Sports/ Cultural/Extra Co curricular/ NSS/NCC or any other event shall be considered on duty. His/ Her shortage of lectures shall be condoned, provided that the student is permitted in writing by the Principal/HOD concerned and a certificate to this effect signed by the competent authority where the student attended the event is taken.

A Student will not be promoted to the next semester unless he/she satisfies the attendance requirement of the present semester as applicable.

Students whose shortage of attendance is not condoned in any semester are not eligible to take their end semester examination of that particular semester and their registration for examination shall stand cancelled and no fee shall be refunded.

15. Late college students: A candidate, who has completed the prescribed course of instructions for a semester but has not appeared in the examination or having appeared, has failed in the examination, may appear as a late college student within the prescribed period.

16. Applications for admission to the examination shall be made on the prescribed form attested by the competent authority as per the college rules.

17. Amount of examination fee to be paid by a candidate for each semester shall be as fixed by the College from time to time.

18. The last date by which examination forms and fees must reach the College office shall be as follows.

Semester	Without late fee	With Late fee of Rs. 800/-	With Late fee of Rs.1200/-	With Late fee of Rs. 5000/-	With Late fee of Rs. 10000/-
Nov./Dec. (Odd)	Sept. 30	Oct.15	Oct. 21	Oct. 31	Nov. 10*
April/May(Even)	Feb. 28	March 15	March 21	March 31	April 15*

***Note: No Examination Form will be accepted after the prescribed date.**

19. College medal will be awarded to a candidate who secures first position in the College on the basis of the marks of all the four semesters taken together. The general rules and conditions of the College/University for the Award of medal/prizes etc. will be applicable in the award of College medal to the topper of this examination.

20 The syllabus for the session shall be such as prescribed by the institute from time to time.

21 The medium of instruction and examination shall be English.

22. **Assessment:**

M.Sc course is Credit Based Semester System (CBSS) as described in the Introduction.

The assessment in all semesters of M.Sc Part- I & II will be 30% internal and 70% external for each paper. The result for the internal examinations shall be conveyed to the students/Examination Branch by the Head of the Department as per approved schedule.

There shall be Two Mid Semester tests in each Semester.

Internal Assessment of 30% will be based on Continuous Comprehensive Assessment (CCA) pattern and the breakup of 30% will be as under:

(i) Average of Two mid Semester Tests : 40%

(ii) Assignment/Seminar/Class Test/Tutorial/Quiz etc. : 40%

(iii) Attendance : 20%

Papers having practical/viva, the marks of theory and practical/viva will be reduced equally percentage wise to make room for 30% internal assessment.

Note: If a case comes to notice of Controller of Examinations where the marks awarded by the Teacher are on a very Higher/Lower side, the award will be got moderated by the following committee.

I. Paper Evaluator
II. Head of the Department
III. Controller of Examination

A candidate is required to secure at least 35% marks both in external examination (Theory and Practical/ Project work) and in internal assessment separately in each paper in order to qualify in an examination.

Students should be shown the internal assessment before submission. In case the student is dissatisfied with the marks awarded to him/her in internal assessment; he/she can approach the concerned teacher. If the student is still not satisfied he/she may approach the head of department and the Principal subsequently.

In case such a paper is dropped from the course of study as a result of any revision the department would indicate a suitable substitute paper in lieu thereof.

23. **End-Semester Examination:**

End-semester examination(s) of each theory course shall be of three hours duration and will be conducted as per norms and schedule notified by the Controller of Examination. The end semester examinations of laboratory/practical courses and other courses such as seminar, colloquium, field work, project, dissertation etc. shall be conducted as notified by the HOD.

24. **Degree Requirement:**

The result of all the examinations will be declared through the College website.

The grace marks shall be allowed according to the general ordinances relating to 'Award of Grace Marks'. These ordinances will apply to all examinations.

(i) Up to 1% of the total marks of Part-I and II examination shall be added to the aggregate of both Part-I and Part-II examinations to award a higher division/55%marks, to a candidate.

(ii) Grace marks to be given shall be calculated on the basis of 1% of total aggregate marks of all the written and practical papers of the examination concerned. Marks for viva-voce/internal assessment/sessional work/skill in teaching/any additional /optional subject shall not be taken into account for this purpose. If a fraction works out to half or more, it shall count as one mark and fractional less than half shall be ignored

(iii) To pass in one or more written papers or subjects, and/or to make up the aggregate to pass the examination but not in sessional work, internal assessment, viva-voce and skill in teaching.

The College may from time to time revise, amend and change the regulations or the curriculum, if formed necessary.

A student who earns total specified credits according to the curriculum and fulfills such other conditions as may be mentioned in the curriculum of the programme shall be issued the DMC and shall be awarded degree by Punjabi University Patiala. He/she must also pay all College dues as per rules. Moreover, there should be no case of indiscipline pending against him/her.

25. If any student gets admission after concealing any fact or his/her certificates are found fake after verification or he/she misleads the institution as any front or because of any other reason, his/her admission will stand cancelled/ his/her result cancelled though he/she may have been declared pass.

26. In case the ordinance is silent about any issue, it will be decided by the College Principal in consultation with the Academic Advisory Committee of the college in the anticipation of approval of the same by Academic Council of the College.

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Programme specific outcome (PSO)1

M.Sc.Physics -I

- Understanding the basic concepts of physics particularly concepts in classical mechanics, quantum mechanics, electrodynamics and electronics to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws.
- Learn to carry out experiments in basic as well as certain advanced areas of physics such as nuclear physics, electronics and lasers.
- A research oriented learning that develops analytical and integrative problem-solving approaches.

M.SC. (PHYSICS) PART-I
(SEMESTER I & II)

Code	Title of Paper	Credits*	Max Marks			Examination Time (Hours)
			Total	Ext.	Int.	
SEMESTER I						
Core Papers						
MPHY 101	Mathematical Methods of Physics–I	4	100	70	30	03
MPHY 102	Classical Mechanics	4	100	70	30	03
MPHY 103	Classical Electrodynamics	4	100	70	30	03
MPHY 104	Quantum Mechanics	4	100	70	30	03
Elective Papers (Only One)						
MPHY 105	(i) Electronics-I	4	100	70	30	03
MPHY 106	(ii) Microwave and its propagation					
Laboratory						
MPHY 107	Laboratory Practice: i) Electronics Lab ii) Optics Lab	5	100	70	-	03
	Laboratory Seminar				30	
SEMESTER –II						
Core Papers						
MPHY 201	Mathematical Methods of Physics– II	4	100	70	30	03
MPHY 202	Advanced Classical Mechanics	4	100	70	30	03
MPHY 203	Advanced Classical Electrodynamics	4	100	70	30	03
MPHY 204	Advanced Quantum Mechanics	4	100	70	30	03
Elective Papers (Only One)						
MPHY 205	i) Electronics –II	4	100	70	30	03
MPHY 206	ii) Physics of Electronic Devices & Fabrication of Integrated Circuits and Systems					
Laboratory						
MPHY 207	Laboratory Practice: i) Electronics Lab ii) Optics Lab	5	100	70	-	03
	Laboratory Seminar				30	

NOTE: 1 Hour = 1 credit for theory examinations and 2 Hours = 1 credit for practical examinations*

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SEMESTER– I

MPHY 101: MATHEMATICAL METHODS OF PHYSICS– I

Maximum Marks: External	**70**	**Time Allowed: 3 Hours**
Internal	**30**	**Total Teaching hours: 50**
Total	**100**	**Pass Marks: 35 %**

Objectives: *The aim and objective of the course on Mathematical Methods of Physics- I is to equip the M.Sc student with the mathematical techniques for understanding theoretical treatment in different courses. Knowledge about Vector calculus, Bessel Functions, Legendre Differential equations, complex variable, Laplace transforms, Fourier Series etc and their physical significance is learnt by the students.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed.

SECTION A

Vector calculus: Vector differential Operators: Del, Gradient, Divergence and Curl, their physical interpretations.

Bessel functions: Definition of Bessel functions of 1^{st} and 2^{nd} kind, Generating function of Jn(x) and their recurrence relations and orthogonality, Definition of spherical Bessel functions and their asymptotic form and its physical significance.

Legendre differential equation: Solution of Legendre differential equation, Legendre polynomials, Rodrigue's formula, Generating function for Legendre polynomials and recurrence relations, Orthogonality of Legendre polynomials. Associated Legendre polynomials and their properties and its physical significance.

Complex variables: Elements of Complex analysis, Limit and continuity, Cauchy's Riemann equations, Complex integrations, Cauchy's theorem for simply and multiply connected regions, Cauchy's integral formula, Taylor and Laurent's series, Poles and singularities, Cauchy's residue theorem and its application to evaluation of definite integrals.

SECTION B

Laplace transforms: Definition, Conditions of existence, Functions of exponential orders, Laplace transform of elementary functions, Basic theorems of Laplace transforms, Laplace transform of special functions, Inverse Laplace transforms, its properties and related theorems, Convolution theorem, Use of Laplace transforms in the solution of differential equations with constant and variable coefficients and simultaneous differential equations and its physical significance.

Fourier series and transform: Dirichlet conditions, Expansion of periodic functions in Fourier series, Complex form of Fourier series, Sine and Cosine series, The finite Fourier sine and cosine transforms, Fourier integral theorem and Fourier transform, Parsevall's identity for Fourier series and transforms. Convolutions theorem for Fourier transforms, Fourier series solutions and its physical significance

Statistical Analysis of Data: Elementary probability theory, Random variables: Discrete and continuous random variables, Probability distributions: Binomial, Poisson and Normal distributions, Central limit theorem.

Text Books:

1. Applied Mathematics, L.R. Pipes and L.A. & Harwill, McGraw Hill Publications

Reference Book:

1. *Mathematical Physics: B.S. Rajput, Pragati Parkashan, Meerut.*
2. *Mathematical Physics, G.R. Arfken, H.I. Weber, Academic Press.*
3. *Fundamentals of Mathematical Statistics, S.C. Gupta ,V.K. Kapoor ,Sultan Chand &Sons*
4. *Laplace Transforms, M.R. Spiegel, Schaum Series, McGraw Hill Publication.*
5. *Linear Algebra by Schaum outline Series.*
6. *Mathematical Physics with classical mechanics, Satyaprakash, Sultan Chand &Sons*

MPHY 102: CLASSICAL MECHANICS

Maximum Marks: External 70 **Time Allowed: 3 Hours**
Internal 30 **Total Teaching hours: 50**
Total 100 **Pass Marks: 35 %**

Objectives: *The aim and objective of the course on Classical Mechanics is to train the students of M.Sc class in the Lagrangian and Hamiltonian formalism, conservation theorems, Hamilton's equations, Canonical Transformations to an extent that they can use these in the modern branches like Quantum Mechanics, Quantum field theory, Condensed Matter Physics, Astrophysics etc.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Newtonian formulation: Conservation laws for a system of particles, Related numerical problems.

Lagrangian formulation: Constraints and generalized coordinates, Principle of virtual work, D'Alembert principle, Lagrangian formulation. Related numerical problems.

Variational principle: Hamilton's principle, Calculus of variations, Lagrange's equations from Hamilton principle. Extension to non-holonomic systems, generalized momentum, Cyclic coordinates Symmetry properties and Conservation theorems. Related numerical problems.

SECTION B

Hamiltonian formulation: Legendre transformation, Hamilton's equations of motion, Hamilton's equation from variational principle, Principle of least action. Related numerical problems.

Canonical transformation: The equations of canonical transformation, examples of canonical transformation and harmonic oscillator problem, Poisson brackets and their canonical invariance, Equations of motion in Poisson bracket formulation, Poisson bracket relations between components of linear and angular momenta. Hamilton-Jacobi equations for Hamilton principal and characteristic functions. Action- angle variables. Related numerical problems.

Text Book:

1. Classical Mechanics, H. Goldstein, Narosa Publishing House, New Delhi.

Reference Books:

1. *J.C. Upadyaya, Classical Mechanics, Revised Edition, Himalaya Publishing Company.*
2. *G. Aruldas, Classical Mechanics, Prentice Hall of India Pvt. Ltd.*
3. *K.D.Krori, Fundamentals of Special and General Relativity, PHI Learning Pvt. Ltd.*
4. *S.K. Srivastava, General Relativity and Cosmology, PHI learning Pvt. Ltd.*
5. *Classical Mechanics, Gupta, Kumar and Sharma, Pragati Prakashan.*
6. *Classical Mechanics, N.C. Rana and P.S. Joag, Tata McGraw-Hill.*

MPHY 103: CLASSICAL ELECTRODYNAMICS

Maximum Marks: External 70 **Time Allowed: 3 Hours**

Internal 30 **Total Teaching hours: 50**

Total 100 **Pass Marks: 35 %**

Objectives: *After successful completion of the course, the student is expected to have gained a clear understanding of Maxwell's equations and have grasped the idea of electrostatics and magneto statics along with time varying fields.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Electrostatics: Coulomb's law, Electric field, Evaluation of electric field due to uniformly charged sphere using Coulomb's law, Differential form of Gauss law, Dirac delta function and its properties, Representation of charge density by Dirac delta function, Equations of electrostatics, Scalar potential and potential due to arbitrary charge distribution, Discontinuities in electric field, Electric potential, Poisson and Laplace equations, Dirichlet and Neumann boundary conditions, Uniqueness theorem Electrostatic potential energy for continuous charge distributions, Energy density.

Boundary value problems in electrostatics: Boundary value problems in one and two dimensions in Cartesian, spherical and cylindrical coordinates. Methods of images, Point charge placed near a grounded sheet and near a grounded conducting sphere.

SECTION B

Magneto statics: Continuity equation, Biot-Savart's law, Differential equations of magneto statics and Ampere's law, Vector potential and its calculation, Magnetic moment, Macroscopic equations, Boundary conditions on B and E, Magnetic scalar potential.

Time varying fields: Faraday's law of electromagnetic induction, Energy in the Magnetic field, Maxwell equations, Displacement current, Electromagnetic potential, Lorentz and Coulomb gauge. Maxwell equations in terms of electromagnetic potentials, Solution of Maxwell equations in Coulomb Gauge and Lorentz gauge by Green function.

Text Book:

1. Classical Electrodynamics, J.D. Jackson, Wiley Eastern Ltd.

Reference Books:

1. Introduction to Electrodynamics by David J. Griffiths, PHI.

2. Electromagnetic waves and radiating systems by Edward C. Jordan, Kaith G. Balmain,Prentice-Hall.

3. Modern Problems in Classical Electrodynamics (Physics) by Charles A. Brau, Oxford University Press.

4. Classical Electrodynamics by Walter Greiner, Springer.

5. Classical Electrodynamics, by S. P. Puri Tata McGraw Hill Publishing Company.

6. *Classical Electricity and Magnetism, by Wolfgang K. H. Panofsky, Melba Phillips, Reprint of the Addison-Wesley Publishing Company.*

MPHY 104: QUANTUM MECHANICS

Maximum Marks: External	**70**	**Time Allowed: 3 Hours**
Internal	**30**	**Total Teaching hours: 50**
Total	**100**	**Pass Marks: 35 %**

Objectives*: The aim and objective of the course on Quantum Mechanics is to introduce the students of M.Sc to the formal structure of the subject and to equip them with techniques of Linear vector spaces, Hilbert space, concepts of basis and operators and bra and ket notation, Schrödinger, Heisenberg and interaction formulations, theory of angular momentum and spin matrices, orbital angular momentum and Clebsh Gordan Coefficients, Space-time symmetries and conservation law and theory of identical particles so that they can use these in various branches of Physics as per requirement.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Linear vector spaces: State vectors, linear independent and linear dependent vectors, Orthonormality, Hilbert spaces

Operators: Commutator algebra, Hermitian, unitary and projection operators and their properties. Unitary transformation, Dirac Bra and Ket Notation: Matrix representations of bras and ket's and operators; Continuous basis, Change of basis-Representation theory. Coordinate and momentum representations, Postulates of quantum mechanics, Generalized uncertainty principle; time-energy uncertainty principle. Schrodinger, Heisenberg & Interaction pictures.

Angular momentum: Eigen values, Matrix representations of J^2, J_z, J_+, J_-; Spin: Pauli matrices and their properties, Spin wave functions for two spin-½ system, Addition of spin and orbital momentum, Addition of two angular momenta: Clebsch-Gordon coefficients and their properties, derivation of C.G. coefficients for ½+½ and ½+1.

SECTION B

Linear Harmonic Oscillator: Solution of Simple harmonic oscillator; Vibrational spectra of diatomic molecule; anisotropic three dimensional oscillators in Cartesian coordinates, Isotropic three dimensional oscillator in spherical coordinates. Matrix mechanical treatment of linear harmonic oscillator: Energy Eigen values and Eigen vectors of SHO, Matrix representation of creation and annihilation operators, Zero-point energy.

Symmetry Principles: Introduction of Symmetry and conservation laws, Space time translation and rotations. Conservation of linear momentum, energy and angular momentum. Symmetry and Degeneracy, space inversion and parity. Time reversal invariance.

Text Books:

1. Quantum Mechanics: Concepts and applications by Nouredine Zettili.

Reference Books:

1. *Quantum Mechanics : V.K. Thankappan, New Age International Publications.*
2. *Quantum Mechanics: P.M. Mathews and K. Venkatesan, Tata-McGraw Publications.*
3. *Quantum Mechanics: L. I. Schiff (Int. Student Ed.), McGraw Hill Co. Ltd.*
4. *Quantum Mechanics: W. Greiner, Springer Verlag Pub., Germany.*
5. *Modern Quantum Mechanics: J. J. Sakurai, Addison Wesley Publication.*
6. *Introduction to Quantum Mechanics by David Griffiths, Pearson Publication.*
7. *Quantum Mechanics: M.P. Khanna, Har-Anand Publication, Delhi.*

MPHY 105: ELECTRONICS–I ELECTIVE PAPER: OPTION (I)

Maximum Marks: External	**70**	**Time Allowed: 3 Hours**
Internal	**30**	**Total Teaching hours: 50**
Total	**100**	**Pass Marks: 35 %**

Objectives*: On completion of this course the student will learn about the Field effect transistors, Bipolar junction transistors, amplifiers, Oscillators and their applications, Digital electronics basics using logic gates and working of major digital devices like flip flops, multivibrators etc.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Semiconductor Devices: Tunnel diode. SCR, TRIAC, DIAC, UJT.

Analog Circuits: Two port network analysis: Active circuit model's equivalent circuit for BJT, Trans-conductance model: Common emitter, Common Base, Common collector amplifiers. Equivalent circuit for FET. Common source amplifier. Source follower circuit.

Linear amplifiers: Multistage amplifier, Direct coupled CE two stage amplifier. RC coupling and its analysis in mid- high-and low-frequency range. Bandwidth of cascaded amplifiers. The gain band-width product for transistor. Darlington Circuits.

Power amplifiers: Operating conditions, Power relations, Non-linear Distortion, Class A power amplifier, Class B Power Amplifier. Push-Pull principle.

Oscillators: Feedback sinusoidal oscillators: phase shift oscillators, Wein bridge oscillators, Tuned circuit oscillators, Hartley and Colpitt's Oscillators, Crystal Oscillators.

SECTION B

Number Systems: Binary, octal and hexadecimal number systems. Arithmetic operations: Binary fractions, Negative binary numbers, floating point representation, Binary codes: weighted and non weighted binary codes, BCD codes, Excess-3 code, Gay codes, binary to Gray code and Gray to binary code conversion, error detecting and error correcting codes.

Logic Gates: AND, OR, NOT, OE operations: Boolean identities, De-Morgan's theorem: Simplification of Boolean functions. NAND, NOR gates.

Combinational logic: Minterms, Maxterms, K-map (up to 4 variables), POS, SOP forms. Decoders. Code converters, Full adder, Multiple divider circuits.

Flip flops: RS, JK-, D- and T-flip flops set up and hold times, preset and clear operations.

Applications of Flip Flops: Counters and Shift registers

Switching devices: Classification and characteristics of logic families (Introduction), Multi-vibrators: bistable multivibrators, monostable and astable multivibrators. Schmitt Trigger circuits.

Text Books:

1. Electronic Fundamentals and Applications: J.D. Ryder, Prentice Hall of India.

Reference Books:

1. *Electronic Devices and Circuits: G.K. Mithal, Khanna Publishers*
2. *Digital Principles and Applications: A.P. Malvino & D.P. Leach, Tata McGraw-Hill, New Delhi*
3. *An Introduction to Digital Electronics: M. Singh, Kalyani Publishers, New Delhi.*
4. *Modern Digital Electronics, R.P.Jain, McGraw Hills.*
5. *Semiconductor Devices & Circuits, Aloke K. Dutta, Oxford Higher Education.*
6. *Digital Fundamentals, Floyd, Pearson International Edition*

MPHY 106: MICROWAVE AND ITS PROPAGATION ELECTIVE PAPER: OPTION (II)

Maximum Marks: External 70 **Time Allowed: 3 Hours**

Internal 30 **Total Teaching hours: 50**

Total 100 **Pass Marks: 35 %**

***Objectives**: On completion of this course the student will learn about Microwave linear beam tubes, microwave crossed beam tubes, Microwave transistor and tunnel diodes, Microwave FET, Charged coupled devices, Transmission lines and microwave measurements*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Microwave linear beam tubes: Conventional vacuum tubes, Klystrons, resonant cavities, velocity modulation process, branching process, output power and beam loading; multi cavity klystron amplifiers, reflex klystrons, helix travelling wave tubes, slow wave structures.

Microwave crossed field tubes: Magnetron oscillators: cylindrical, linear and coaxial, forward wave crossed field amplifier, backward wave crossed field amplifier, backward wave crossed field oscillator, their principle of operation and characteristics.

Microwave transistor and tunnel diodes: Microwave bipolar transistors, physical structures, configurations, principles of operation, amplification phenomena, power- frequency limitations, hetero junction bipolar transistors, physical structures, operational mechanism and electronic applications, microwave tunnel diodes, principles of operation, microwave characteristics.

Microwave field effect transistors: Junction field effect transistors, metal semiconductor field effect transistors, high electron mobility transistors, metal oxide semiconductor field effect transistors, physical structures, principle of operation and their characteristics. MOS transistor and memory devices: NMOS, CMOS and memories.

Charged coupled devices: Operational mechanism, surface channel CCD's dynamic characteristics.

SECTION B

Transferred electron devices: Gunn effect diodes, Ridley-Walkins-Hilsum theory, modes of operation, LSA diodes, InP diodes, CdTe diodes, microwave generation and amplification.

Avalanche transit time devices: Read diode, IMPATT diodes, TRAPATT diodes, BARITT diodes, their physical structure, principle of operation and characteristics.

Microwave measurements: Measurement of impedance, attenuation, insertion loss, coupling and directivity, frequency, power and wavelength at microwave frequencies.

Microwave transmission lines: Transmission line equations and solutions, reflection coefficient and transmission coefficient, standing wave and standing wave ratio, line impedance and admittance, Smith chart, impedance matching. Microwave cavities, microwave hybrid circuits, directional couplers, circulators and isolators.

Text Books:

1. Microwave Devices and Circuits: Sameul Y. Liao, Pearson Education
2. Microwaves: K.C. Gupta, Wiley Eastern Limited.

MPHY 107: LABORATORY PRACTICE: I) ELECTRONIC LAB II) OPTICS LAB

Maximum Marks: 70 **Time allowed: 3 Hours**

Pass Marks: 45% **Total teaching hours: 100**

Objectives: The aim and objective of the course on Laboratory Practice is to expose the students of M.Sc. to the experimental techniques in Electronics and Optics Physics so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.

This paper comprises of laboratory experiments based on **Optics** in one group and **Electronics** in the other group. Each student will be placed in one of the two groups during the entire semester. There is no internal assessment in this paper.

GROUP-I ELECTRONICS EXPERIMENTS: (10 out of the followings)

1. Study the gain frequency response of a given RC coupled BJT, CE amplifier.
2. Study of Clipping & Clamping circuits.
3. Study of shunt capacitor filter, inductor filter, LC filter and π filter using Bridge Rectifier.
4. Find the energy gap of a given semi conductor by reverse bias junction method.
5. To calculate the temperature coefficient of Thermistor.
6. Verify De-Morgan's law and various combinations of gates using Logic gates circuit.
7. Study of various types of Flip-Flops.
8. To study various Oscillators (Hartley, Colpit, RC Phase shift etc.).
9. To study Amplitude Modulation and De-Modulation and calculate modulation index.
10. To study characteristics of FET and determine its various parameters.
11. Study the characteristics of Tunnel Diode.
12. To study 2 bit, 3 bit and 4 bit Adder & Subtractor.
13. Study the characteristics of basic Thyristors (SCR, MOSFET, UJT, TRIAC etc.).
14. Use of Transistor as a push pull amplifier (Class 'A', 'B' and 'AB').
15. Application of transistor as a series voltage regulator.
16. Study of biasing techniques of BJT.
17. To study Frequency Modulation and Demodulation.
18. Study of transistor as CE, CB and CC amplifier.
19. Fourier series analysis of square, triangular and rectified wave signals.

GROUP-II LASERS AND OPTICS EXPERIMENTS: (10 out of the followings)

1. To study the optical bench model of microscope and to determine the numerical aperture of the microscope.
2. To study the optical bench model of telescope and to determine the angular field of view and magnifying power by entrance and exit pupil method.
3. To study the characteristics of solar cell.
4. To study the magnetostriction in an iron rod using Michelson interferometer.
5. To study the optical thickness of mica sheet using channel spectrum interferometry.
6. To determine the Planck's constant using photovoltaic cell.
7. To obtain the coherence matrix and stokes parameters for (i) unpolarized light (ii) polarized light and hence to determine their degree of polarization.
8. To study the aberrations of a convex lens.
9. To study the electro-optic effect in $LiNbO_3$ crystal using He-Ne laser.
10. To study B-H curve.
11. To study the characteristics of optoelectronic devices (LED, Photodiode, Photodiode, Phototransistor, LDR).
12. To study the diffraction pattern by pin hole, single slit, double slit and grating and to calculate the wavelength of He-Ne laser.
13. To study microwave optics system for reflection, refraction, polarization phenomena.
14. To calibrate the prism spectrometer using mercury lamp and to determine the refractive index of material of the prism for a given wavelength of light.
15. Measurement of Brewster angle and refractive index of materials like glass and fused silica (with He-Ne laser) with a specially designed spectrometer.
16. Particle size determination by diode laser
17. Study of optical fiber communication kit.

LABORATORY SEMINAR

Maximum Marks: 30 (Internal) **Time allowed: 3 Hours**
Pass Marks: 45% **Total teaching hours: 20**

This paper comprises of Seminars based on laboratory experiments in **Optics** and **Electronics.** There is no external examination and awards are based on internal assessment in this paper.

SEMESTER – II

MPHY 201: MATHEMATICAL METHODS OF PHYSICS– II

Maximum Marks: External 70 **Time Allowed: 3 Hours**

Internal 30 **Total Teaching hours: 50**

Total 100 **Pass Marks: 35 %**

Objectives*: The aim and objective of the course on Mathematical Methods of Physics- II is to equip the M.Sc. student with the mathematical techniques for understanding theoretical treatment indifferent courses.*

The knowledge of Hermite & Laguerre Polynomials, Tensors, Partial Differential equations and Group theory help to solve plenty of problems in higher Physics. Numerical analysis helps to solve problems of computational physics and develop a strong background if he chooses to pursue research in Physics as a career.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks.Use of scientific calculators is allowed.

SECTION-A

Hermite Polynomials: Solution of Hermite differential equation, Generating function and recurrence relations for Hermite polynomials, Rodrigue's formula and orthogonality and its physical significance.

Laguerre Polynomials: Laguerre differential equation and its solution, Properties of Laguerre and associated Laguerre functions and its physical significance.

Tensor: Cartesian tensors, Vector components and their transformation properties under three dimensional rotation in rectangular coordinates, Direct product of two and more tensors, Tensors of second and higher ranks, Symmetric and anti-symmetric tensors, Contraction and differentiation, Kronecker and alternating tensors and their isotropy property, Contra-variant and covariant tensors, Physical examples of second rank tensors. Green’s function and its properties (in brief).

SECTION-B

Evaluation of Polynomials: Interpolation and Extrapolation: Difference operators, Finite differences method, Lagrange's interpolation, least square fitting; Differentiation and Integration: Simpson and trapezoidal rules; solution of first order differential equation using Euler method, Taylor method, Runge- Kutta method and the physical significance of methods.

Partial differential equations: One dimensional wave equation, The vibrating string fixed at both ends, Vibrations of a freely hanging chain, vibrations of rectangular membrane,
Vibrations of a circular membrane, Temperature distribution in a rectangular and circular plate.

Group theory: Group postulates, Multiplication table, conjugate elements and classes sub-group, Isomorphism and homomorphism, Discrete groups, Permutation groups, Lie group and Lie algebra, Reducible and irreducible representation, Young diagrams and direct product; SU(2) and SU(3) groups.

Text Books:

1. Applied Mathematics, L.R. Pipes and L.A. & Harwill, McGraw Hill Publications

Reference Book:

1. *Mathematical Physics: B.S. Rajput, Pragati Parkashan, Meerut.*
2. *Mathematical Physics, G.R.Arfken, H.I. Weber, Academic Press, USA (Ind. Ed.)*
3. *Cartesian Tensors, H. Jeffreys, Cambridge University, Press.*
4. *Mathematical Physics with classical mechanics, Satyaprakash, Sultan Chand &Sons*
5. *Numerical methods, J H Mathew, Prentice Hall of India.*

MPHY 202: ADVANCED CLASSICAL MECHANICS

Maximum Marks: External	**70**	**Time Allowed: 3 Hours**
Internal	**30**	**Total Teaching hours: 50**
Total	**100**	**Pass Marks: 35 %**

Objectives*: The aim and objective of the course is to enables the students to understand Two body central force problem, Special theory of relativity, Kinematics and Dynamics of rigid body in detail and ideas regarding Euler's equations of motion, Theory of small oscillations in detail along with basis of Free vibrations and Theory of rigid body kinematics and dynamics.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed.

SECTION A

Two-body central force problem: Equivalent one body problem, Equation of motion and first integrals, Conditions for closure of orbits, Equivalent one dimensional problem, Classification of orbits, Differential equation for the orbit, Kepler's problem. Scattering in a central force field, Transformation of scattering problem to laboratory coordinates, Rutherford's formula.

Special theory of relativity: Lorentz transformation, covariant formulation, Force, momentum and energy equation in relativistic mechanics, Lagrangian and Hamiltonian formulation of relativistic mechanics.

Small oscillations: Formulation of problem, Eigen value equation, Frequencies of free vibration and normal modes.

SECTION B

Rigid body kinematics: Kinematics of rotation of rigid body about a point, Orthogonal transformation and properties of transformation matrix, Euler angles and Euler theorem, Infinitesimal rotations, Rate of change of vector in rotating frame.

Rigid body dynamics: Angular momentum and kinetic energy of rotation of rigid body about a point, Inertia tensor and its Eigen values, Principal moments, Principal axes transformation. Euler equations of motion

Text Book:

1. Classical Mechanics, H. Goldstein, Narosa Publishing House, New Delhi.

Reference Books:

1. *J.C. Upadyaya, Classical Mechanics, Revised Edition, Himalaya Publishing Company.*
2. *G. Aruldas, Classical Mechanics, Prentice Hall of India Pvt. Ltd.*
3. *K.D. Krori, Fundamentals of Special and General Relativity, PHI Learning Pvt. Ltd.*
4. *S.K. Srivastava, General Relativity and Cosmology, PHI learning Pvt. Ltd.*
5. *Classical Mechanics, Gupta, Kumar and Sharma, Pragati Prakashan.*
6. *Classical Mechanics, N.C. Rana and P.S. Joag, Tata McGraw-Hill.*

MPHY 203: ADVANCED CLASSICAL ELECTRODYNAMICS

Maximum Marks: External 70 **Time Allowed: 3 Hours**

Internal 30 **Total Teaching hours: 50**

Total 100 **Pass Marks: 35 %**

Objectives*: After successful completion of the course, the student is expected to have gained a clear understanding of Maxwell's equations and know that laws of reflection, refraction are outcomes of electromagnetic boundary conditions and boundary value problems in electrostatics. They will also be able design dielectric coatings which act like antireflection coatings.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed.

SECTION A

Maxwell inhomogeneous equations and conservation laws: Poynting theorem and Maxwell stress tensor, Poynting theorem for harmonic fields. Fields and radiation of a localized oscillating source, Electric dipole fields and radiation, Magnetic dipole field, Centre fed linear antenna.

SECTION B

Electromagnetic waves and wave propagation: Plane waves in a non-conducting medium, Polarization and Stokes parameter, Energy flux in a plane wave, Reflection and refraction across a dielectric interface, Total internal reflection, Polarization by reflection, Waves in a conducting medium and skin depth.

Introduction to wave guide and its analysis: TM modes in wave guides, Rectangular waveguides: TM and TE Modes, waveguide: wavelength, impedance and its power calculations.

Text Book:

1. Classical Electrodynamics, J.D. Jackson, Wiley Eastern Ltd.

Reference Books:

1. Introduction to Electrodynamics by David J. Griffiths, PHI.

2. Electromagnetic waves and radiating systems by Edward C. Jordan, Kaith G. Balmain,Prentice-Hall.

3. Modern Problems in Classical Electrodynamics (Physics) by Charles A. Brau, Oxford University Press.

4. Classical Electrodynamics by Walter Greiner, Springer.

5. Classical Electrodynamics, by S. P. Puri Tata McGraw Hill Publishing Company.

6. *Classical Electricity and Magnetism, by Wolfgang K. H. Panofsky, Melba Phillips, Reprint of the Addison-Wesley Publishing Company.*

MPHY 204: ADVANCED QUANTUM MECHANICS

Maximum Marks: External 70 **Time Allowed: 3 Hours**

Internal 30 **Total Teaching hours: 50**

Total 100 **Pass Marks: 35 %**

Objectives*: After successful completion of this paper, the student will be well-versed in Time Dependent and independent Perturbation Theory, Variational Method, WKB Method, Collision Theory and Relativistic Quantum Mechanics.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed.

SECTION A

Identical Particles: In-distinguishability principle, Symmetry and anti-symmetry of wave functions, Exchange operators, Spin statistic theorem, Slater determinant, Scattering of identical particles. *Problems*: Hydrogen molecule.

Time Independent Perturbation Theory: First order and second order perturbation theory for non-degenerate case; *Problems*: An-harmonic oscillator, He-atom; Degenerate perturbation theory, *Problems*: Stark effect, Zeeman effect.

Time Dependent Perturbation Theory: Transition probability for constant and harmonic perturbation, Selection rules, Fermi Golden rule, Induced absorption and emission, Einstein coefficients; *Problems*: Radiative transitions.

Variational Method: Rayleigh Ritz variational method for ground & excited States, *Problems:* Ground state energy of hydrogen, helium and harmonic oscillator.

SECTION B

WKB Method in One Dimension: Classical limit, Principle of WKB, Connection formulae for penetration of a barrier; *Problem*: Alpha decay.

Collision Theory: Scattering amplitudes and cross section, Integral equation of scattering amplitude, Born approximation. Partial wave analysis: Scattering by central potential, Short range interaction, Phase shifts, Optical theorem, s and p-wave scattering, Scattering length.

Relativistic Quantum Mechanics: Klein-Gordon equation: Probability and current densities, Continuity equation, Difficulties of K.G. equation, Plane wave solution. Dirac equation: Dirac algebra, Plane wave solutions, Hole theory, Non-relativistic limit.

Text Books:

1. Quantum Mechanics: Concepts and applications by Nouredine Zettili.

Reference Books:

1. *Quantum Mechanics : V.K. Thankappan, New Age International Publications.*
2. *Quantum Mechanics: P.M. Mathews and K. Venkatesan, Tata-McGraw Publications.*
3. *Quantum Mechanics: L. I. Schiff (Int. Student Ed.), McGraw Hill Co. Ltd.*
4. *Quantum Mechanics: W. Greiner, Springer Verlag Pub., Germany.*
5. *Modern Quantum Mechanics: J. J. Sakurai, Addison Wesley Publication.*
6. *Introduction to Quantum Mechanics by David Griffiths, Pearson Publication*
7. *Quantum Mechanics: M.P. Khanna, Har-Anand Publication.*

MPHY 205: ELECTRONICS–II ELECTIVE PAPER: OPTION (I)

Maximum Marks: External	**70**	**Time Allowed: 3 Hours**
Internal	**30**	**Total Teaching hours: 50**
Total	**100**	**Pass Marks: 35 %**

Objectives*: On completion of this course the student will learn about Operational amplifiers, comparator and applications, Voltage regulators and features of Timer 555, Transistor Biasing Circuits, Modulation and communications, Comparator and applications.*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B andC. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Transistor Biasing Circuits: Operating point, need of Biasing circuits, Different Biasing Circuits: Fixed Bias Circuit, Collector to Base Bias, Emitter Bias, and Voltage Divider Biasing circuit.

Modulation & Communication : Amplitude Modulation, generation of AM waves, Demodulation of AM waves. Frequency modulation, Digital communication: basic idea about (delta modulation, Pulse Code Modulation and Pulse Width Modulation).

Operational amplifiers: Ideal operational amplifier. Inverting and non-inverting amplifiers, Differential amplifiers, CMMR, Internal circuit of operational amplifier, Examples of practical operational amplifier, Operational amplifier characteristics, DC and AC characteristics, slew rate.

SECTION-B

Operational amplifier applications: Instrumentation amplifier. AC amplifier. V to I and I to V converters. Precision diode circuits. Sample and hold circuits. Log and antilog amplifiers. Differentiator and Integrator. Analog Computation.

Comparator and applications: Multivibrators using Op amplifier, Astable Multivibrator using Op-amplifier (square wave generator), Triangular wave generator, Sine wave generator.

Voltage regulators: series Op. Amp. Regulator, IC regulators and 723 general purpose regulators.

Features of Timer 555: Monostable Multivibrator, Astable Multivibrator, IC 555 Timer as Schmitt Trigger.

Text Books:

1. Electronic Fundamentals and Applications: J.D. Ryder, Prentice Hall of India (5th Ed.), N. Delhi.

Reference Books:

1. *Linear Integrated Circuit: D. Roy Choudury and Shail Jain, Wiley Eastern, New Delhi*
2. *Op-Amps & Linear Integrated circuits, Rama Kant A. Gayakward, Pearson.*
3. *An Introduction to Analog and Digital Communication, Simon Haykins, Wiley Publication'*
4. *Electronic Devices & Circuits, G.K.Mithal, Khanna Publications.*
5. *Digital and analog communication systems, K. Sam Shanmugam, Wiley publications.*
6. *Integrated Electronics, Milliman & Halkias, McGraw Hills*

MPHY 206: PHYSICS OF ELECTRONIC DEVICES & FABRICATION OF INTEGRATED CIRCUITS AND SYSTEMS (ELECTIVE PAPER): OPTION (II)

Maximum Marks: External 70 **Time Allowed: 3 Hours**

Internal 30 **Total Teaching hours: 50**

Total 100 **Pass Marks: 35 %**

Objectives*: On completion of this course the student will learn about Microwave devices, photonic devices and fabrication of integrated devices*

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

INSTRUCTION FOR THE PAPER SETTER:

The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

INSTRUCTION FOR THE CANDIDATES:

The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed.

SECTION A

Microwave Devices: Gunn Diode**,** Tunnel diode, Schottky Diode, Impatt diode, Varactor Diode (tuning diode)

Photonic Devices: Radiative and non-Radiative transitions. Optional Absorption, Bulk and Thin film Photo-conductive devices (LDR), diode photo-detectors, solar cell- (open circuit voltage and short circuit current, fill factor) LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), diode lasers (conditions for population inversion, in active region, light confinement factor. Optional gain and threshold current for lasing, Fabry-Perrot Cavity Length for lasing and the separation between modes)

SECTION B

Memory and other Electronic Devices: Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, non-volatile-NMOS, magnetic, optical and ferroelectric memories, charge coupled devices (CCD).

Others Electronic Devices: Electro-Optic, Magneto-Optic and Acousto-Optic Effects. Material Properties related to get these effects. Important Ferroelectric, Liquid Crystal and Polymeric materials for these devices. Piezoelectric, Electro-strictive and magneto-strictive Effects, Important materials exhibiting these properties, and their applications in sensors and actuator devices. Acoustic Delay lines, piezoelectric resonators and filters. High frequency piezoelectric devices: Surface Acoustic Wave Devices. Piezoelectric effect. Inorganic oxide and Polymer Pyro-electric materials and their applications.

Fabrication of integrated Devices: Thin film Deposition Techniques: Thermal Oxidation, Lithography: UV Photolithography, X-Ray Lithography Chemical Vapor Deposition (CVD), MOCVD, Plasma enhanced chemical vapor deposition(PECVD). Physical Vapor deposition: Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering and Laser Ablation. Etching and Micro-machining of Silicon, Fabrication steps of Integrated Circuits and Integrated Micro-Electro-Mechanical-Systems (MEMS)

Text Book

1. The Physics of Semiconductor Devices by D.A, Eraser, Oxford Physics Series (1986)

Reference Books:

1. *Semiconductor Devices-Physics and Technology, by SM Sze Wiley.*
2. *Introduction to semiconductor devices, M.S. Tyagi, John Wiley & Sons*
3. *Measurement, Instrumentation and Experimental Design in Physics and Engineering by M. Sayer and A. Mansingh, Prentice Hall, India.*
4. *Solid state electronics, Ben G. Streetman.*
5. *Fundamental of Micro fabrication, Marc Madou.*
6. *Microwave Devices & circuits, Samuel liao, Pearson.*

MPHY 207: LABORATORY PRACTICE: I) ELECTRONIC LAB II) OPTICS LAB

Maximum Marks: 70 **Time allowed: 3 Hours**

Pass Marks: 45% **Total teaching hours: 100**

Objectives*: The aim and objective of the course on Laboratory Practice is to expose the students of M.Sc. to the experimental techniques in Electronics and Optics Physics so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.*

This paper comprises of laboratory experiments based on **Optics** in one group and **Electronics** in the other group. Each student will be placed in one of the two groups during the entire semester. There is no internal assessment in this paper.

GROUP-I ELECTRONICS EXPERIMENTS: (10 out of the followings)

1. Study the gain frequency response of a given RC coupled BJT, CE amplifier.
2. Study of Clipping & Clamping circuits.
3. Study of shunt capacitor filter, inductor filter, LC filter and π filter using Bridge Rectifier.
4. Find the energy gap of a given semi conductor by reverse bias junction method.
5. To calculate the temperature coefficient of Thermistor.
6. Verify De-Morgan's law and various combinations of gates using Logic gates circuit.
7. Study of various types of Flip-Flops.
8. To study various Oscillators (Hartley, Colpit, RC Phase shift etc.).
9. To study Amplitude Modulation and De-Modulation and calculate modulation index.
10. To study characteristics of FET and determine its various parameters.
11. Study the characteristics of Tunnel Diode.
12. To study 2 bit, 3 bit and 4 bit Adder & Subtractor.
13. Study the characteristics of basic Thyristors (SCR, MOSFET, UJT, TRIAC etc.).
14. Use of Transistor as a push pull amplifier (Class 'A', 'B' and 'AB').
15. Application of transistor as a series voltage regulator.
16. Study of biasing techniques of BJT.
17. To study Frequency Modulation and Demodulation.
18. Study of transistor as CE, CB and CC amplifier.
19. Fourier series analysis of square, triangular and rectified wave signals.

GROUP-II LASERS AND OPTICS EXPERIMENTS: (10 out of the followings)

1. To study the optical bench model of microscope and to determine the numerical aperture of the microscope.
2. To study the optical bench model of telescope and to determine the angular field of view and magnifying power by entrance and exit pupil method.
3. To study the characteristics of solar cell.
4. To study the magnetostriction in an iron rod using Michelson interferometer.
5. To study the optical thickness of mica sheet using channel spectrum interferometry.
6. To determine the Planck's constant using photovoltaic cell.
7. To obtain the coherence matrix and stokes parameters for (i) unpolarized light (ii) polarized light and hence to determine their degree of polarization.
8. To study the aberrations of a convex lens.
9. To study the electro-optic effect in $LiNbO_3$ crystal using He-Ne laser.
10. To study B-H curve.
11. To study the characteristics of optoelectronic devices (LED, Photodiode, Photodiode, Phototransistor, LDR).
12. To study the diffraction pattern by pin hole, single slit, double slit and grating and to calculate the wavelength of He-Ne laser.
13. To study microwave optics system for reflection, refraction, polarization phenomena.
14. To calibrate the prism spectrometer using mercury lamp and to determine the refractive index of material of the prism for a given wavelength of light.
15. Measurement of Brewster angle and refractive index of materials like glass and fused silica (with He-Ne laser) with a specially designed spectrometer.
16. Particle size determination by diode laser
17. Study of optical fiber communication kit.

ABORATORY
SEMINAR

Maximum Marks: 30 (Internal) **Time allowed: 3 Hours**
Pass Marks: 45% **Total teaching hours: 20**

This paper comprises of Seminars based on laboratory experiments in **Optics** and **Electronics.** There is no external examination and awards are based on internal assessment in this paper.

PROGRAMME SPECIFIC OUTCOME (PSO) 2

M.Sc.Physics -II

The M.Sc.-II (Physics) Program includes various core courses such as condensed matter physics, statistical mechanics, nuclear and particle physics, spectroscopy and computational physics. The choice of advanced elective courses offers a glimpse in the frontier areas of research and allows students to work on research projects. The program also provide adequate exposure to the students for pursuing higher education in the field of technology (M. Tech.), Physics (M.Phil./Ph.D.) and other job opportunities in academia and industry. The diverse lab experiments allow students to understand the fundamental aspects of the subject.

M.SC. (PHYSICS) Part-II
(SEMESTER III & IV)

(SEMESTER III)

CODE	TITLE OF PAPER	CREDITS	MAX MARKS			EXAMINATION
			Total	Ext.	Int.	TIME (HOURS)
CORE PAPERS						
MPHY 301	Condensed Matter Physics I	4	100	70	30	03
MPHY 302	Nuclear Physics	4	100	70	30	03
MPHY 303	Statistical Mechanics & Thermodynamics	4	100	70	30	03
MPHY 304	Computational Physics I	3	100	35	15	1.5
	Computational Physics I: Practical	1		50	-	1.5
ELECTIVE PAPERS* (ANY ONE OF FOLLOWING)						
MPHY 305	Laser Physics	4	100	70	30	03
MPHY 306	Material Science					
LABORATORY						
MPHY 307	Laboratory Practice:	4	100	70	-	03
	i) Nuclear Physics & Counter Electronics Laboratory					
	ii) Condensed Matter Physics and Advanced Electronics Laboratory					
	iii) Seminar	1			30	

(SEMESTER –IV)

CODE	TITLE OF PAPER	CREDITS	MAX MARKS			EXAMINATION
			Total	Ext.	Int.	TIME (HOURS)
CORE PAPERS						
MPHY 401	Condensed Matter Physics II	4	100	70	30	03
MPHY 402	Nuclear and Particle Physics	4	100	70	30	03
MPHY 403	Atomic and Molecular Physics	4	100	70	30	03
MPHY 404	Computational Physics II	3	100	35	15	1.5
	Computational Physics II: Practical	1		50	-	1.5
ELECTIVE PAPERS* (ANY ONE OF FOLLOWING)						
MPHY 405	Experimental techniques in Nuclear Physics	4	100	70	30	03
MPHY 406	Experimental Techniques in Physics					
LABORATORY						
MPHY 407	Laboratory Practice:	4	100	70	-	03
	i) Nuclear Physics & Counter Electronics Laboratory					
	ii) Condensed Matter Physics and Advanced Electronics Laboratory					
	iii) Seminar	1			30	
MPHY 408	Project Work **	9		200		

NOTE:

I. *Only one optional paper will be offered depending on the availability of staff.

II. **Top 5 students up to result of M.Sc, first year will do project work (MPHY 408) in lieu of (MPHY 404 and MPHY 407) with available staff.

APPROVED
Member Secretary
Academic Council

APPROVED
Principal
General Shivdev Singh Diwan Gurbachan Singh
Khalsa College Patiala

(Semester III)

MPHY 301: CONDENSED MATTER PHYSICS -I

4 CREDITS

Theory:	**70 marks**	**Time Allowed: 3 Hours**
Internal:	**30 marks**	**Total Teaching hours: 50**
Total:	**100 marks**	**Pass Marks: 35 %**

Objectives: The aim and objective of the course is to expose the students to the topics like elastic constants, lattice vibrations, dielectric properties, energy band theory and transport theory so that they are equipped with the techniques used in investigating these aspects of the matter in condensed phase.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Diffraction methods, Lattice vibrations, Free electrons: Diffraction methods, Scattered wave amplitude, Reciprocal lattice, Brillouin zones, Structure factor, Quasi Crystals, Form factor and Debye Waller factor, Bonding of solids, Lattice vibrations of mono-atomic and diatomic linear lattices, IR absorption, Neutron scattering, Free electron gas in 1-D and 3-D. Heat capacity of metals, Thermal effective mass, Drude model of electrical conductivity, Wiedman-Franz law, Hall effect, Quantized Hall effect.

SECTION B

Semiconductor Physics: Nearly free electron model, Bloch functions, Kronig-penny model, Wave equation of electrons in a periodic potential, Solution of the central equation, Solutions near a zone boundary, Number of orbital's in a band, Metals and insulators.

Semiconductors and Fermi-surfaces in Metals: Band gap, Equation of motion, properties of holes, Effective mass of electrons (m*), m* in semiconductors, Band structure of Si-Ge and GaAs, Intrinsic carrier concentration, Intrinsic and extrinsic conductivity, Thermoelectric Effects, Semimetals, Different zone schemes, Constructions of Fermi surfaces, Experimental methods in Fermi surface studies, Quantization of orbits in a magnetic field, Magnetic breakdown.

Text Books:

1. Introduction to Solid State Physics; C. Kittel (7^{th} Ed.), Wiley Eastern, N. Delhi, 1995.

Reference Books:

1. Solid State Physics, S. O. Pillai (9^{th} Ed.), New Age International Pvt Ltd, 2020.
2. Solid State Physics; A.J. Dekker (2^{nd} Ed.), McMillan India Ltd.

MPHY 302: NUCLEAR PHYSICS
4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to familiarize the students to the basic aspects of nuclear physics like properties of nuclei, nuclear forces, nuclear models and nuclear reactions so that they are equipped with the techniques used in studying these things.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.
Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed.

SECTION A

Nuclear Properties: Nuclear Radius, Mass and Abundance of Nuclides, Nuclear Binding Energy, Nuclear Angular Momentum and Parity, Nuclear Electromagnetic Moments, Nuclear Excited States.
Forces between Nucleons: Deuteron problem, Nucleon-Nucleon scattering, Proton-Proton and Neutron-Neutron interactions, Properties of Nuclear Forces, Exchange Force Model.
Nuclear Models: Semi-empirical Mass Formula, Shell Model (Single and many particle), Even-Z Even-N Nuclei and Collective Structure, Single Particle States in Deformed Nuclei.

SECTION B

Nuclear Reactions-I: Types of Nuclear Reactions and Conservation Laws, Energetic of Nuclear Reactions, Isospin, Reaction cross-sections.
Nuclear Reactions-II: Experimental Techniques, Coulomb Scattering, Nuclear Scattering, Optical Model, Fission and Fusion, Compound and Non-Compound Nuclear Reactions, Nuclear Resonance, Direct Reactions, Heavy Ion Reactions.

Text Books:

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, New York (2016).
2. Nuclear Physics: D. C. Tayal, Himalaya Publishing House (2016).

Reference Books:

1. Nuclear Physics: R.R. Roy and B.P. Nigam, New Age Pub., N. Delhi (2009)
2. Nuclear Physics: W.E. Burcham and M. Jobes (Ind. Ed.), Addison Wesley.
3. Basic ideas and concepts in nuclear Physics: K. Heyde, Overseas Press India (2005)
4. Nuclear Physics: Experimental and Theoretical: H. S. Hans, New Academic Science Ltd., Second Revised edition, (2010).

MPHY 303: STATISTICAL MECHANICS AND THERMODYNAMICS

4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to familiarize the students to the theoretical techniques used in understanding the interacting systems, phase transitions and the non-equilibrium phenomena so that they can use these in different branches of physics, chemistry and biology.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed.

SECTION A

Classical Statistical Mechanics Postulates, the macroscopic and microscopic states, contact between statistics and thermodynamics, connection between statistical and thermodynamic quantities, Liouville's theorem, Phase space, Ensemble, Micro canonical ensemble, Entropy of an ideal gas, Gibb's paradox.
Distribution function, Boltzmann transport equations, Boltzmann's H-theorem

Canonical ensemble and its thermodynamics, Partition function, Classical ideal gas in canonical ensemble, Energy fluctuations. Equi-partition theorem, Grand canonical ensemble and its thermodynamics, Density fluctuations. Equivalence of canonical and the grand canonical ensembles. Ideal gas in grand canonical ensemble, Planck's distribution law, Black body radiation.

SECTION B

Postulates of Quantum Statistical Mechanics, Density matrix, ensembles in quantum statistical mechanics, Ideal Fermi Gas: Equation of state of an Ideal Fermi Gas, Degeneracy, Fermi energy at T=0 and at low temperatures. Bose Gas: Equation of state of an Ideal Bose gas, Bose-Einstein condensation, Density matrix, Equation of motion for density matrix.
Phase transition, first order phase transition: the Clausius Claperyon equation, fluctuations in: canonical and Grand canonical ensembles, random walk and Brownian motion. Diffusion equation, Introduction to non-equilibrium process.

Text Book:

1. Statistical Mechanics by R.K. Patharia, 2nd Edition, Butterworth-Heinemann, Oxford (2005).

Reference Books:

1. Statistical Mechanics by K. Huang, 2nd Edition, Wiley Eastern, New Delhi (2011).
2. Statistical Mechanics by Satya Prakash, 1st Edition, Kedar Nath Ram Nath Publishers, Meerut (2019).

MPHY 304: COMPUTATIONAL PHYSICS-I
THEORY & (PRACTICAL)
3 Credits:

Max. Marks: Theory	35	Time Allowed: 1.5+1.5 Hours
Internal	15	Theory Teaching hours: 25
Practical	50	Practical Teaching hours: 50
Total	100	Total Teaching Hours: 75
		Pass Marks: 35 %

Objectives: The aim and objective of the course is to familiarize the students with the numerical methods used in computation and programming using C++ language so that they can use these in solving simple problems pertaining to Physics.

Note: The Computational Physics paper will consist of two parts –

a) Written examination covering Section A of duration one and half hour. Question paper will be set by the external examiner.
b) Practical examination (External) covering section B of duration one and half hour's duration.

Instruction for the Paper Setter:
Written examination: The question paper will consist of two Part I and II. Part I will have (04) four questions from Section A of the syllabus. Each question will carry (07) mark each. Part II will have (07) seven short answer type compulsory questions of 2 marks each, which will cover the entire Section A uniformly. Part I carry 21 marks and Part II carry 14 marks.
Practical examination: The question paper will consist of one Part I. Part I will have five questions from section B of the syllabus. Each question will carry (15) mark each.

Instruction for the candidates for written examination: The candidates are required to attempt three questions from Part I and the entire Part II. Each question of Part I carries 07 marks and Part II carries 14 marks. Use of scientific calculators is allowed.

Instruction for the candidates for Practical examination: The candidates are required to attempt two questions from Part I. Each question carries 15 marks. Viva voice would be of 20 marks. Use of scientific calculators is allowed.

SECTION A

Evolution of OOP: Paradigm, advantages and disadvantages of OOP and its characteristics

Introduction to C++: Identifiers, keywords, data types, constants and variable declaration, operators, Manipulators, Input output statements, stream input output.

Storage classes: Scope rules of variables, Automatic, register, static and external storage class.

Array: Definition its types and array as a character string.

Implementation of Numerical Methods: Numerical Methods, Newton Raphson Method, Secant Method and fixed-Point iteration method for simple roots and its convergence.

Interpolation: Lagrange's Interpolation. Solution of Simultaneous algebraic equations, Gauss Elimination method, pivoting of conditioned equation, Gauss Seidel iterative method, comparison of direct and iterative method.
Introduction to Statistics: Meaning, Scope, collection, classification of data. Application based on the measures of central tendency (mean, mode median, geometric mean, standard deviation covariance), dispersion.

SECTION B

PROGRAMS
1. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.

2. Choose a set of 10 values and find the least squared fitted curve.
3. Generation of waves on superposition like stationary waves and beats.
4. Fourier analysis of square waves.
5. To find the roots of quadratic equations.
6. Wave packet and uncertainty principle.
7. Find first order derivative at given x for a set of 10 values with the help of Lagrange interpolation.
8. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.
9. Perform numerical integration on 1-D function using Simpson and Weddle rules.
10. To find determinant of a matrix - its eigenvalues and eigenvectors.

Text Books:

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co.) 4th edition.
2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition 2011.
3. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition (2008).
4. Computational Physics: R. C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 1st Edition (2005).
5. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 2nd edition (2002).

MPHY 305: LASER PHYSICS (ELECTIVE PAPERS)
4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Out of 100 Marks, internal assessment (based on two mid-semester tests/internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Objectives: The aim and objective of the course is to expose the students about the introductory concepts of lasers, types of lasers, laser spectroscopy and interaction of radiation with matter

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.
Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Introductory Concepts: Absorption, Spontaneous and stimulated emission, Properties of laser light.
Photon-atom interaction: Rates of absorption and stimulated emission, Allowed and forbidden transitions, Line broadening mechanisms, Transition cross-section, Absorption and gain coefficient, Non-radiative decay.
Pumping processes: Optical and electrical pumping, Passive optical resonators: Photon lifetime and cavity Q. Plane parallel resonator.
Laser rate equation: Three level and four level lasers, Optimum output coupling, Laser spiking.

SECTION B

Types of lasers: Ruby lasers, Nd: YAG laser, He-Ne laser, CO2 laser, N2 laser, Excimer laser, Dye lasers, Chemical lasers, Semiconductor lasers, Colour center and free electron lasers.
Nonlinear optics: Harmonic generation, Phase matching, Optical mixing, Parametric generation of light, Self focussing, Multiquantum photoelectric effect. Two photon process theory and experiment. Violation of the square law dependence. Doppler-free two photon spectroscopy. Multiphoton processes. Phase conjugation.
Optical fibre, its properties and fabrication: Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter.

Text Books:

1. Principles of Lasers: O. Svelto,(3rd Ed.), Plenum Press
2. Lasers and its applications: A.K. Ghatak and K. Thyagrajan
3. Lasers and Nonlinear Optics: B.B. Laud (2nd Ed.), Wiley Eastern
4. Laser Electronics: J.T. Verdeyen (2nd Ed.), PHI
5. The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall) (1993).

MPHY306: MATERIAL SCIENCE
4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to expose the students with crystal imperfections, diffusion in solids, mechanical properties and phase transitions of materials.

Out of 100 Marks, internal assessment (based on two mid-semester tests/internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Crystal Imperfections and its Classification: Point imperfections, Line imperfections; Mixed dislocations. Characteristics of dislocations; Sources of dislocations, their effects and remedies; Phenomena related to behaviour of dislocations, Surface imperfections, Volumes imperfections, Whiskers.

Diffusion in solids: Diffusion controlled applications, Types of diffusion, Diffusion processes, Laws of diffusion, Solution to Fick's second law, Applications based on second law, Experimental determination of diffusivity, Factors affecting diffusivity.

Mechanical Properties:

Basic properties: Strain, Stress, Young's modulus, Elastic constants, Isotropy, Anisotropy, Orthotropy, Homogeneity and heterogeneity; Stress-strain diagrams, Stress-strain diagram of structural steel, Elastic properties; Other mechanical properties: Strength, Stiffness, Elasticity, Plasticity, Resilience, Proof resilience, Toughness, Ductility, Brittleness and malleability, True stress-strain diagrams, Fatigue and Creep Mechanical Tests: Destructive tests, Tensile test, Compression tests, Shear and bending (on Flexure) tests, Torsion test, Hardness tests, Impact tests, Fatigue test and Creep test.

SECTION B

Phases and Phase diagrams

Solid phases in alloys, Solid solution, Inter-metallic compounds and intermediate compounds, Phases, Phase diagrams, Binary phase diagram, typical phase diagrams, Application of phase diagrams, Ternary phase diagram.

Phase Transformations and Heat Treatment

Rate of cooling and crystallization, Strengthening mechanisms; Cold and hot working; Precipitation (or Age) hardening, Dispersion hardening, Solid solution hardening, Recovery and re-crystallization, Grain growth and preferred orientation. Purpose of heat treatment, Microstructure of steel and iron, Iron-Carbon phase diagram, Transformation in steel and critical cooling curve, Heating temperature range in various heat treatment processes, Hardening, Tempering, Annealing, Normalizing, Case hardening or carburizing, Cyaniding, Nitriding, Flame hardening, Induction hardening and Jaminy End-quenched test.

Text Books:

1. Material Science and Engineering: K.M. Gupta (Ist Ed.), Umesh Pub., Delhi
2. Material Science: Abdul Mubeen and Farhat Mubeen (2nd Ed.), Khanna Pub., Delhi
3. Materials Science and Engineering - A First course by V. Raghavan (6th Ed), Prentice hall, India
4. Physical Metallurgy by Vijender Singh, Standard Publishers Distributors.
5. Heat Treatment: Principles and Techniques by T.V. Rajan, C.P. Sharma and Ashok Sharma (2nd Ed.), PHI Learning Private Limited, New Delhi.

MPHY 307: LABORATORY PRACTICE

Maximum Marks: 100 Time allowed: 3 Hours
Practical: 70 Pass Marks: 45%
Seminar: 30 Total teaching hours: 100

Objectives: The aim and objective of the course is to train the students to advanced experimental techniques in general physics, electronics, nuclear physics, condensed matter physics so that they can investigate various relevant aspects and are confident to handle sophisticated equipment and analyze the data.

This paper comprises of laboratory experiments based on **Nuclear Physics & Counter Electronics** in one group and **Condensed Matter Physics and advanced Electronics** in the other group. Each student will be placed in one of the two groups during the entire semester. There is no internal assessment in this paper.

GROUP-I: NUCLEAR PHYSICS & COUNTER ELECTRONICS EXPERIMENTS (10 out of the followings)

1. Study of standard deviation using G-M counter
2. Half-life of ^{40}K using G-M Counter
3. Measurement of mass absorption coefficient of beta rays in given materials
4. To find range and energy of β- particles
5. To find Dead time of a GM Tube
6. Study of energy calibration of NaI(Tl) scintillation detector
7. Study and analysis of spectrum of ^{137}Cs
8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer.
9. Study of Compton scattering law for energy of scattered photons
10. To study Internal Conversion Coefficient for ^{137}Cs (or suitable gamma source)
11. To determine the source strength of a given radioactive gamma source
12. Study and analysis of the spectrum of ^{60}Co
13. Photoelectric cross-section measurement for a given target material at known incident gamma photon energy
14. Compton cross-section measurement for known incident gamma photon energy
15. Measurement of Photo-peak (full energy peak) efficiency of Scintillation detector.
16. To study various Encoders and Decoders, and Random Access Memory (RAM) circuit.
17. To study the various counters.
18. To study the left and right shift registers and ring counters.
19. To study the operation of multiplexer and de-multiplexer circuits.
20. To find the operating voltage of GM Counter and to find its plateau region.
21. To find the operating voltage of Scintillation detector.

GROUP-II: CONDENSED MATTER PHYSICS AND ADVANCED ELECTRONICS EXPERIMENTS
(10 out of the followings)

1. Find the value of the 'g' factor in a DPPH sample by using ESR technique.
2. To determine the Curie temperature of a given PZT sample.
3. Determine the coercivity, retentivity and saturation value of magnetic induction of the given sample by studying the B-H loop.
4. Determine the Hall coefficient of the given sample and hence find the carrier concentration and mobility.
5. Find the band gap energy of the given semi-conductor sample by four probe method.
6. Measurement of susceptibility of paramagnetic solutions by Quinck's Tube Method.
7. Measurement of magneto-resistance of a semi-conducting sample.
8. Study of Dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
9. Study of solar cell and characteristics
10. Frank Hertz experiment for Quantization of Bohr's model of atom.
11. To study Digital to Analog Converter and Analog to Digital Converter.
12. To study multivibrators (a stable, monostable and bistable) using discrete components.

13. To study the multivibrators (BMV, AMV and MMV) using IC-555.
14. To study Timer Integrated circuit IC-555.
15. To study the basic operational amplifier (Model 741).
16. To study the applications of operational amplifier (Model 741).
17. To study the voltage-controlled oscillator (VCO)
18. To study the voltage regulator using IC 317

(SEMESTER–IV)

MPHY 401: CONDENSED MATTER PHYSICS–II

4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to familiarize the students with relatively advanced topics like optical properties, magnetism, superconductivity, magnetic resonance techniques and disordered solids so that they are confident to use the relevant techniques in their later career.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Magnetic properties: Langevin diamagnetism equation, Quantum theory of diamagnetism of mononuclear system, Paramagnetism, Quantum theory of para-magnetism, magnetism of rare earth and iron group ions, Crystal field splitting, Quenching of orbital angular momentum, Conduction electron magnetization, Cooling by adiabatic demagnetization, Ferromagnetism, Magnetization at absolute zero and its temperature dependence, Spin waves and magnons in ferromagnetic's, Neutron magnetic scattering, Ferrimagnetic order and iron garnets, Anti ferromagnetic order and susceptibility, Anti ferromagnetic magnons, Ferromagnetic domains, Bloch wall, Origin of domains, Application of soft and hard magnetic materials.

SECTION B

Superconductivity: Survey of traditional and high Tc superconductors, Meissner effect, Heat capacity, Energy gap, Isotope effect, Stabilization energy density, London equations, Coherence length, Some basic ideas of BCS theory, Flux quantization in superconducting ring, Duration of persistent currents, Type II Superconductors, Estimation of HC1 and HC2 , Single particle Tunnelling, DC and AC Josephson effects. Macroscopic quantum interference, SQUIDS and its applications.

Lattice defects: Point defects, diffusion, Ionic conductivity, Photoconductivity, Concepts of traps, Colour centers, Shear strength in single crystals, Dislocations and its types, Burger's vector, Stress field of dislocations. Low angle and large angle grain boundaries. Dislocation multiplication by Frank-Read source and strength of alloys.

Text Books:

1. Introduction to Solid State Physics: C. Kittel (7^{th} Ed.), Wiley Eastern Ltd.,1995 **Reference Books**:

Reference Books:

1. Solid State Physics; A.J. Dekker (2^{nd} Ed.), McMillan India Ltd.
2. Theory of superconductivity; John Robert Schrieffer CRC Press (2018).
3. Solid State Physics, S.O.Pillai, 9^{th} Ed. New Age International Publishers (2020).
4. Introduction to Solids, Leonid Azaroff , McGraw-Hill, USA (2001)

MPHY402: NUCLEAR AND PARTICLE PHYSICS

4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to expose the students to the relatively advanced topics in nuclear decays, invariance principles and conservation laws, hadron-hadron interactions, relativistic kinematics, static quark model of hadrons and weak interactions so that they grasp the basics of fundamental particles in proper perspective.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION A

Alpha Decay: Why alpha decay occurs? Basic alpha decay processes, Alpha decay systematic, Theory of alpha emission, Angular momentum and Parity in Alpha Decay. **Beta Decay:** Energy Released in Beta Decay, Fermi Theory of Beta Decay, Angular Momentum and Parity Selection Rules, Comparative Half Lives and Forbidden Decays, Neutrino Physics, Non-conservation of Parity.

Gamma Decay: Energetic of gamma decay, Angular momentum and Parity selection rules, Internal conversion.

SECTION B

Particles and Forces: Classification and Properties of elementary particles and Fundamental Forces.

Conservation Laws: Isospin, Strangeness, Hypercharge, Baryons and Leptons Conservation, C, P and CP Violation in Weak Interactions, K-decays, CPT invariance (Statement and consequences).

Meson Physics: Yukawa's Hypothesis, Discovery and properties of exchange bosons.

Strange Particles: Mass and lifetime for K-meson, Relativistic kinematics**,** Gellmann-Nishijima Scheme, Baryons and Meson Multiplets.

Quark Model: Types and Properties of Quarks, Paradoxes of Quark Model, Meson Octet, Baryon Octet, Baryon Decouplet, Colour Quantum Number.

Text Books:

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, New York (2016)
2. Introduction to High Energy Physics: D. H. Perkins, Cambridge University Press, 4th Edition (2000).
3. Introduction to Particle Physics: M. P. Khanna, Prentice Hall of India Pvt. Ltd (2004)

Reference *Books:*

1. Introduction to Elementary Particles: D.J. Griffiths, Wiley-VCH, 2nd Edition (2008).
2. The atomic nucleus by R. D. Evans, Krieger Publishing Company (1982)

MPHY 403: ATOMIC AND MOLECULAR PHYSICS

4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to know about different atom model and how to differentiate different atomic systems, different coupling schemes and their interactions with magnetic and electric fields. Students will gain ability to apply the techniques of microwave and infrared spectroscopy to elucidate the structure of molecules and the principle of Raman spectroscopy and its applications in the different field of science & Technology. Students become familiar with different resonance spectroscopic techniques and its applications and learn to find solutions to problems related different spectroscopic systems.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION-A

Spectra of one and two valance electron systems:

Quantum states of electron in an atom, Electron Spin, Vector model for one and two valance electron, Spin orbit interaction and fine structure of hydrogen, relativistic corrections in energy levels for hydrogen atoms, Lamb shift, Hyperfine Structure and isotope effects, Spectroscopic notations for L-S and J-J couplings, Spectra of alkali and alkaline atoms, L-S and J-J coupling for two electron system.

Effects of external fields on atom:

The Zeeman Effect, Normal and Anomalous Zeeman effect, Paschen-Back effect, Stark effect.

SECTION-B

Microwave and Infra-Red Spectroscopy:

Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator (Microwave region spectroscopy), Diatomic vibrating rotator, vibration-rotation spectrum (Infrared region spectroscopy).

Raman and Electronic Spectroscopy:

Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibration Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer Approximation- The Franck-Condon principle, Electron spin resonance, Nuclear magnetic resonance.

Text Books:

1. Introduction to Atomic Spectra: H.E. White-Auckland Mc Graw Hill
2. Fundamentals of Molecular spectroscopy: C.N. Banwell and E. M. McCASH, 4th Edition, Mc Graw Hill (2017).

Reference Books:

1. Introduction to Molecular Spectroscopy: G.M. Barrow-Tokyo Mc Graw Hill.
2. Physics of atoms and molecules: B. H. Bransden and C. J. Joachan Pearson

MPHY 404: COMPUTATIONAL PHYSICS-II
4 Credits:

Max. Marks: Theory	35	Time Allowed: 1.5+1.5 Hours
Internal	15	Theory Teaching hours: 25
Practical	50	Practical Teaching hours: 50
Total	100	Total Teaching Hours: 75
		Pass Marks: 35 %

Objectives: The aim and objective of the course is to familiarize the students with the numerical methods used in computation and programming using C++ language so that they can use these in solving simple problems pertaining to Physics.

Note: The Computational Physics paper will consist of two parts –

a) Written examination covering Section A of duration one and half hour. Question paper will be set by the external examiner.
b) Practical examination (External) covering section B of duration one and half hour's duration.

Instruction for the Paper Setter:
Written examination: The question paper will consist of two Part I and II. Part I will have (04) four questions from Section A of the syllabus. Each question will carry (07) mark each. Part II will have (07) seven short answer type compulsory questions of 2 marks each, which will cover the entire Section A uniformly. Part I carry 21 marks and Part II carry 14 marks.

Practical examination: The question paper will consist of one Part I. Part I will have five questions from section B of the syllabus. Each question will carry (15) mark each.

Instruction for the candidates for written examination: The candidates are required to attempt three questions from Part I and the entire Part II. Each question of Part I carries 07 marks and Part II carries 14 marks. Use of scientific calculators is allowed.

Instruction for the candidates for Practical examination: The candidates are required to attempt two questions from Part I. Each question carries 15 marks. Viva voice would be of 20 marks. Use of scientific calculators is allowed.

SECTION A

Classes and Objects: Class Declaration and class Definition, Defining member functions, making functions inline, Nesting of member functions, Members access control, This Pointer, Union as space saving classes.
Objects: Object as a function argument, array of objects, functions returning objects, friend functions and friend classes.
Constructors: Properties, types of constructor (Default, parameterized and copy), Dynamic constructor, multiple constructor in classes. Destructors: properties, Destroying objects, Rules for constructors and destructors.

Pointers: Pointer operations, pointer arithmetic, pointers and arrays, pointer to functions. Functions: prototyping, Definition and call, Scope Rules. Parameter Passing: By value, By address and by reference, Functions returning references, Const functions, recursion, function overloading, Default Arguments, Const Arguments. **Correlation and regression analysis:** Product moment correlation-coefficient-rank correlation coefficient- simple regression- method of least squares for estimation of regression coefficient.

Iterative methods: Bisection, False position, Secant method, Newton Raphson method for two variables.
Differential equations: Taylors method, Euler's method, Rung kutta, second and fourth order method.
Numerical differentiation and integration: Differentiation formulae based on polynomial fit, pitfalls in Differentiation, Trapezoidal and Simpson rules.

SECTION-B

PROGRAMS

1. Write a program to accept two positive integers and compute ^{n}pr.
2. Write a program to read a list of N numbers of integer type in an array. It modifies the list by multiplying 5 to every element in the list. The modified list is displayed.

3. Write a program that reads two matrices A and B of the order m, n and compute C = A+B, where C is a third matrix.
4. Write a program to demonstrate the usage of constructors and destructors.
5. Write a program to demonstrate the relation between correlation and regression analysis.
6. Write a program for Taylors Method.
7. Write a program for Euler's Method.
8. Write a program for Rung Kutta Method.
9. Write a program for Bisection Method.
10. Write a program for Newton Raphson Method for two variables.
11. Write a program for Secant Method.

Text Books

1. Numerical Mathematical Analysis by J.B. Scarborough, Oxford Book Co.
2. Object oriented Programming by Lafore
3. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 2nd edition (2002).
4. Numerical Methods by S. R. K. Iyengar and R. K. Jain, New Age Int. Ltd, Publishers (2009)

Reference Books:

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co.) 4th edition.
2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition 2011.
3. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition (2008).
4. Computational Physics: R. C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 1st edition (2005).

MPHY 405: EXPERIMENTAL TECHNIQUES IN NUCLEAR PHYSICS

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to expose the students to theoretical aspects of different equipment and methods used in the fields of nuclear physics and particle physics.

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION-A

Data interpretation and analysis: Precision and accuracy, error analysis, propagation of errors, Statistical treatment of experimental data, Least squares fitting of linear and nonlinear functions, chi-square test, Binomial, Poisson and Gaussian distributions.

Interaction of radiation and its detection: Interaction of gamma-rays, neutrons, electrons and heavy charged particles with matter, Relativistic particle interaction, General properties of radiation detectors, pulse-height spectra, energy resolution, detection efficiency, dead time, Back ground radiation and detector shielding.

SECTION-B

Gas-filled detectors: Proportional counters, Gas multiplication factor, space charge effects, energy resolution, Position-sensitive proportional counters.

Organic and inorganic scintillators: Organic and inorganic scintillators and its characteristics, coupling to photomultiplier tubes and photodiodes.

Semiconductor detector: Semiconductor detector in X-ray, gamma-ray Spectroscopy, Ge and Si(Li) detectors, Charge production and collection process, Semiconductor detector in particle identification and Charged particle Spectroscopy (Telescope arrangement, time of flight), Detection of fast and slow neutrons - nuclear reactions for neutron detection, Introduction to recent developments in detectors (Si PIN, Clover detectors)

Text Books:

1. Radiation detection and measurement by G.F. Knoll, Wiley 4th Edition (2010).

Reference Books:

1. Techniques for Nuclear and Particle Physics experiments: W.R. Leo (Springer) (1994).
2. Introduction to Experimental Particle Physics: Richard Fernow, (Cambridge University Press, Cambridge) (1989).
3. Nuclear Radiation Detector by SS Kapoor and V.S. Ramamurthy, John Wiley & Sons, New Age International Publishers (1986).

MPHY 406: EXPERIMENTAL TECHNIQUES IN PHYSICS

4 Credits:

Theory:	70 marks	Time Allowed: 3 Hours
Internal:	30 marks	Total Teaching hours: 50
Total:	100 marks	Pass Marks: 35 %

Objectives: The aim and objective of the course is to expose the students to the understanding of different vacuum pumps and the production and maintenance of vacuum systems and its uses and needs in Physics. They will also understand in depth about thin film preparation and production controlling techniques and the application of thin films in the field of science & Technology. Moreover students have grasped the idea of Cryogenics technology and its applications and understand about different material analysis techniques and applications

Out of 100 Marks, internal assessment (based on two mid-semester tests/ internal examination, written assignment/project work etc. and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Each of sections A and B will have four questions from respective sections of the syllabus. Section C will have 10 short answer type questions, which will cover the entire syllabus uniformly. Each question of sections A and B carry 10 marks. Section C will carry 30 marks.

Instruction for the candidates: The candidates are required to attempt two questions each from sections A and B, and the entire section C. Each question of sections A and B carries 10 marks and section C carries 30 marks. Use of scientific calculators is allowed

SECTION-A

Thin Film Deposition Technology: Thermal evaporation – general considerations and evaporation methods, Cathodic sputtering – sputtering process, glow discharge sputtering, sputtering variants and low pressure sputtering: DC, RF and RF magnetron sputtering (Principle and working), Chemical methods – Electrodeposition and chemical vapour deposition, Vacuum deposition apparatus – vacuum systems: Roughing Pump, Diffusion Pump, Getter ion Pump, surface deposition technology.

Thickness Measurements and Analytical Techniques: Thickness measurement – electrical methods, microbalance monitors, mechanical method, radiation absorption and radiation emission methods, optical interference methods, Analytical techniques – chemical analysis and structural analysis.

SECTION B

Diffraction techniques: Principal, Instrumentation, working and applications of X-ray diffraction, Neutron diffraction, Electron diffraction.

Electron microscopy: Scanning Electron Microscope.

Scanning probe microscopy: Atomic Force Microscope: Principal, Construction & working, Applications.

Spectroscopic Techniques (Basic concepts, Instrumentation & working, Applications): UV-Visible absorption spectroscopy, Raman spectroscopy, Infrared spectroscopy, Luminescence spectroscopy.

Magnetometers: Vibrating sample magnetometer (Basic concept, instrumentation and working).

Text Books:

1. Thin Film Phenomena: K.L. Chopra, McGraw Hill Book Company.

Reference Books:

1. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Yang Leng, John Wiley & Sons (Asia) Pte Ltd.
2. Springer Handbook of Nanotechnology by Bharat Bhushan, Springer.
3. Handbook of Spectroscopy Edited by G Gaugliz and T Vo-Dinh, WILEY VCH Verlag GmbH & Co.
4. Elements of X -Ray Diffraction, B.D.Cuility.
5. Semiconductor Materials and Device Characterization, Dieter K.Schroder, Wiley Publication
6. Handbook of Surfaces and Interfaces of Materials by Hari Singh Nalwa, Five Volume Set, Academic Press, 1st Edition (2001)

MPHY 407: LABORATORY PRACTICE

Maximum Marks: 100 Time allowed: 3 Hours
Practical: 70 Pass Marks: 45%
Seminar: 30 Total teaching hours: 100

Objectives: The aim and objective of the course is to train the students to advanced experimental techniques in general physics, electronics, nuclear physics, condensed matter physics so that they can investigate various relevant aspects and are confident to handle sophisticated equipment and analyze the data.

This paper comprises of laboratory experiments based on **Nuclear Physics & Counter Electronics** in one group and **Condensed Matter Physics and advanced Electronics** in the other group. Each student will be placed in one of the two groups during the entire semester. There is no internal assessment in this paper.

GROUP-I: NUCLEAR PHYSICS & COUNTER ELECTRONICS EXPERIMENTS (10 out of the followings)

1. Study of standard deviation using G-M counter
2. Half-life of ^{40}K using G-M Counter
3. Measurement of mass absorption coefficient of beta rays in given materials
4. To find range and energy of β- particles
5. To find Dead time of a GM Tube
6. Study of energy calibration of NaI(Tl) scintillation detector
7. Study and analysis of spectrum of ^{137}Cs
8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer.
9. Study of Compton scattering law for energy of scattered photons
10. To study Internal Conversion Coefficient for ^{137}Cs (or suitable gamma source)
11. To determine the source strength of a given radioactive gamma source
12. Study and analysis of the spectrum of ^{60}Co
13. Photoelectric cross-section measurement for a given target material at known incident gamma photon energy
14. Compton cross-section measurement for known incident gamma photon energy
15. Measurement of Photo-peak (full energy peak) efficiency of Scintillation detector.
16. To verify the given Boolean identities on the ALU system.
17. To study various Encoders and Decoders, and Random Access Memory (RAM) circuit.
18. To study the various counters.
19. To study the left and right shift registers and ring counters.
20. To study the operation of multiplexer and demultiplexer circuits.
21. To find the operating voltage of GM Counter and to find its plateu region.
22. To find the operating voltage of Scintillation detector.

GROUP-II: CONDENSED MATTER PHYSICS AND ADVANCED ELECTRONICS EXPERIMENTS
(10 out of the followings)

1. Find the value of the 'g' factor in a DPPH sample by using ESR technique.
2. To determine the Curie temperature of a given PZT sample.
3. Determine the coercivity, retentivity and saturation value of magnetic induction of the given sample by studying the B-H loop.
4. Determine the Hall coefficient of the given sample and hence find the carrier concentration and mobility.
5. Find the band gap energy of the given semi-conductor sample by four probe method.
6. Measurement of susceptibility of paramagnetic solutions by Quinck's Tube Method.
7. Measurement of magneto-resistance of a semi-conducting sample.
8. Study of Dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
9. Study of solar cell and characteristics
10. Frank Hertz experiment for Quantization of Bohr's model of atom.

11. To study Digital to Analog Converter and Analog to Digital Converter.
12. To study multivibrators (astable, monostable and bistable) using discrete components.
13. To study the multivibrators (BMV, AMV and MMV) using IC-555.
14. To study Timer Integrated circuit IC-555.
15. To study the basic operational amplifier (Model 741).
16. To study the applications of operational amplifier (Model 741).
17. To study the voltage controlled oscillator (VCO)
18. To study the voltage regulator using IC 317

PHY 408: PROJECT WORK
9 Credits:

Maximum Marks: 200 Pass Marks: 45%

Objectives: The aim and objective of the course is to expose the students to preliminaries and methodology of research in Theoretical and Experimental Physics. Students will get opportunities to participate in ongoing research activities and development of laboratory experiments.

This work would be offered to five (05) students, who are in top merit of examination in their first year. Students will complete the project in given semester, which would be evaluated by external examiner. The students selected for this paper will not appear for paper MPHY 404 and MPHY 407. However the total credits of these students would remain same as other students who are not offered with projects.

The rules for evaluation are as under

The following board will evaluate the dissertation of student, which would be formed as

1. Supervisor
2. HoD/Representative of HoD
3. External Examiner as decided by the Chief Controller, Examinations from list of examiners as provided by BoS, Physics.
4. Member from cognitive area

The breakup of marks for the Project work will be as under:

Project Work Evaluation by Internal Examiner	60 marks
Project Work Evaluation by External Examiner	100 marks
Viva Voce by External Examiner	40 marks

Submission of Project Work:

1. It should be written in English (as per College rules except as allowed otherwise).
2. It must indicate evidence of candidate's knowledge of the main research and techniques prevalent in his/her chosen field of study.
3. It must be satisfactory as regards literary presentation.
4. A candidate will submit one copy (soft binding) of Project work for evaluation and later on after evaluation will submit three copies (hard binding).
5. The student will submit the final thesis in the month of May.

Extension in the Period of Project Work:

Candidates should ordinarily, complete their Project Work within given period but in genuine and hardship cases, the College Principal, on the recommendations of the Supervisor and Head of the Department, may allow extension by paying a fee of Rs. 1000/- per month and for the maximum period of three months.

APPROVED
Member Secretary
Academic Council

APPROVED
Principal
General Shivdev Singh Diwan Gurbachan Singh
Khalsa College Patiala