Puducherry Technological University
Puducherry – 605014

(A Technological University of Government of Puducherry)

Curriculum & Syllabi
for
M.Sc. (Materials Science & Technology) Degree Programme

(With effect from academic year 2020-21)

(Approved in Sixth Academic Council meeting held on 20th March 2021)

1. INTRODUCTION

1.1 The Regulations presented here are common to all the M.Sc. Degree Programmes of Pondicherry Engineering College (PEC) and binding on all parties concerned, including the Students, Faculty, Staff and Departments

1.2 This set of Regulations contains the course structure, curriculum and the provisions governing the policies and procedures of imparting instructions of courses, conducting of examinations and evaluation and certification of students' performance leading to the said Degree Programme(s)

1.3 The set of Regulations, on approval by the Academic Council of PEC, may supersede all the corresponding earlier sets of Regulations of the College, along with all the amendments thereto, and shall be binding on all students undergoing the said Degree Programme(s)

1.4 This set of Regulations may evolve and get revised/refined or updated or modified or changed through appropriate approvals from the Academic Council, from time to time.

1.5 The effect of periodic refinements in the Academic Regulations & Curriculum, on the students *admitted in earlier years*, shall be dealt with appropriately and carefully, so as to ensure that those students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised set of Regulations & Curriculum, without any undue favour or considerations.

1.6 All disputes arising from this set of Regulations must be addressed to the Academic Council. The decision of the Academic Council is final and binding on all the parties concerned.

1.7 Any legal disputes arising from this set of Regulations shall be limited to the legal jurisdiction determined by the location of the college and not that of any other parties.

2. DEFINITIONS

In these regulations, unless the context otherwise requires:

a) **“University”** means Pondicherry University
b) **“College”**/**“PEC**”/**“Institute**” means ,Pondicherry Engineering College
c) “**Principal**” means the Principal of Pondicherry Engineering College
d) “**Programme**”/“**Degree**” means, M.Sc. Degree Programme
e) “**Branch**”/”**Discipline**” means, specialization or discipline of M.Sc. Degree programme like M.Sc in Materials Science & Technology etc.,
f) “**Parent Department**” means, the Department that offers the degree programme
g) “**BoS**” means, the Board of Studies for the programmes offered by a Department
h) “**HoD**” means, Head of the Academic Department
i) “**Course Instructor**” means, a Faculty teaching a theory/laboratory subject
j) “**Course**”means, a theory subject or practical subject offered in a semester
k) “**Core Course**” means, a compulsory subject in the curriculum
l) “**Elective Course**” means, an optional subject in the curriculum
m) “**Odd Semester**” means, the Semester that is typically from Mid-June to October
n) “**Even Semester**” means, the Semester that is typically from December to Mid-April
o) “**Summer Vacation**” means, the inter semester vacation between Even Semester and Odd Semester
p) “**Period**” means, Duration of one unit of a theory/practical class (*shown in the time table*) which is normally 50 minutes
q) “**Day**” means, 8 periods of theory / practical classes in a calendar day
r) “**Week**” means, 5 working days in a calendar week
s) “**Enrollment**” means, Enlistment of a student in the rolls of a class in an academic year
t) “**Arrear**” means, a subject in which a student has failed (*has not fulfilled the examination passing criteria)*
u) “**Regular Examination**” means, an examination conducted in a semester for a subject which is prescribed in the curriculum of that semester
v) “**Arrear Examination**” means, a semester examination conducted exclusively for the students who have failed in previous attempts
w) “**First Attempt**” means*,* appearance in the semester examination of a subject in a semester in which the student has registered for the subject. If a student has registered for a subject in a semester and ‘Absent’ for the semester examination conducted in that semester, it is also treated as the *First Attempt.*
x) “**Higher Learning Institutions**” means, any State or Central University or Institutes of National importance such as IISc/IITs/IIMs/NITs/IISERs
y) “**MoU**” means, Memorandum of Understanding
z) **“He”** includes both genders he and she; Similarly “him” includes “her” as well

3. BRANCHES OF STUDY

College offers M.Sc. Programmes in ***one*** specialization listed below:

1) Materials Science & Technology (*offered by Physics Department*)

4. ELIGIBILITY FOR ADMISSION

All candidates seeking admission to the **First year of M.Sc. (**Materials Science & Technology**) Degree** shall be required to satisfy the eligibility norms given below:

Candidates for admission to the first semester of the Four semesters M.Sc Course should have passed ***Bachelor's Degree in Science*** with Physics as major subject and chemistry and mathematics as ancillaries.
(Or)**B.Sc.** with Chemistry as main subject and Physics and Mathematics as ancillaries.
(Or)**B.Sc. –** Applied Science.
(Or)**B.Sc.** with Physics, Mathematics and/ or Chemistry as major subjects.
(Or)**B.Sc.** Electronics Science with Physics and Mathematics as ancillaries.
(Or)**B.Sc.** Ceramics Technology
(Or)**B.Sc.** Polymer Technology
with a minimum of 55% marks in the curriculum or equivalent CGPA.

Note: *(1) Candidates belonging to Scheduled Caste / Scheduled Tribe who have a mere pass in qualifying examination are eligible. (2) There is no age limit for this programme.*

5. DURATION OF THE PROGRAMME

Duration of the M.Sc. programme shall be Four Semesters [Two years] with 16 instruction weeks per semester. The maximum period to complete the programme shall be eight consecutive semesters [Four years].

6. PROGRAMME STRUCTURE

6.1 The curriculum of M.Sc. Programme will have courses that are categorized as follows:

1) Core Courses (Theory)
2) Elective Courses (Theory)
3) Laboratory Courses
4) Project work, Phase-I
5) Project Work, Phase-II

6.2 **Highlights of the Curriculum**: The curriculum shall have a total of seventeen theory courses of which ten are core courses and the remaining seven are elective courses. Four core courses and two elective courses are offered in the first semester, three core courses and three elective courses are offered in the second semester, three core courses and two elective courses are offered in the third semester. The curriculum, in general, shall have two Laboratory courses each in the first, second and third semesters. A major component of the M.Sc. curriculum is the 'Project Work' which is carried out in two phases: *Phase I* in the third semester and *Phase II* in the fourth semester.

6.3 **Credits**:

i) Each course is assigned a number of credits as follows:

1) 4 credits for all Core theory courses (*4 lecture periods per week*)
2) 3 credits for all Elective theory courses (3 *lecture periods per week*)
3) 2 credits for Laboratory courses (*3 periods per week*)
4) 2 Credits for Project Phase-I and
5) 12 credits for Project Phase-II

Total number of credits of all the courses in the curriculum of the M.Sc. Programme shall be between **85 and 90.**

6.4 ***Elective Courses:***

Elective courses are to be chosen from a list of approved elective courses of M.Sc Programme in a particular semester.

6.5 **Auditing of Elective Courses**:

Students, by auditing a course, are permitted to attend classes but are not required to take examinations and earn credits. Auditing is permitted only for elective courses. A student will be permitted to audit a course only on submission of a *'Letter of Purpose*' to Dean (*Academics*) justifying the need for attending the course and this letter shall be duly forwarded with a recommendation by the Head of the Department. The student is required to maintain an attendance of 90% and above in the audited course. The courses successfully audited by a student in a particular semester will appear with a Letter Grade 'X' in the Grade Card (vide Regulation 10.1).

6.6 **Project Work**

Project Work is envisaged to train a student to analyze independently any problem posed to him/her. The work maybe analytical, experimental, design or combination of both. The student can undertake the project work in the department concerned or in an industry/research laboratory approved by the Head of the Department. The project work shall be carried out during the third semester (*Phase I*) and the fourth semester (*Phase II*).

7. REGISTRATION AND ENROLLMENT

7.1 All the students of the M.Sc. programme shall register for the courses during a specified period in the beginning of the semester provided he fulfills the eligibility criteria prescribed for enrollment and for registration of courses in that particular semester. The Dean (Academics) shall regulate the registration process.

7.2 A student will be eligible for enrolment only if he has cleared all the dues to the Institute, Hostel, and Library up to the end of the previous semester and not been debarred from enrolment by disciplinary action committee of the Institute.

7.3 ***Eligibility for Registration***: A student is eligible to register for courses in the third semester only if he has earned a minimum of 36 credits in the first and second semesters put together. A student who is ineligible to register for courses in the third semester (*due to shortage of minimum required credits*) shall discontinue the programme temporarily and rejoin the third semester (*in the following academic year*) after earning the prescribed minimum number of credits.

7.4 ***Dropping of Courses***: After completing the registration of courses for a particular semester, if for some reason a student wants to drop one or more elective courses, he can do so within three weeks of the commencement of the semester with the written approval of the M.Sc. programme coordinator and the Head of the Department. However, a student is not permitted to drop the core courses.

8. ASSESSMENT PROCEDURE - TESTS AND EXAMINATIONS

8.1 **Theory Courses**:

i) All theory courses shall be assessed as follows:

Assessment Method	**Marks**
Continuous Assessment	40
Semester Examination (Duration: 3 Hours)	60
Total	100

ii) *Continuous Assessmen*t shall be based on two cycle tests carrying 15 marks each and assignments carrying 10 marks. Assignments shall be in the form of problems, small projects, quizzes, design problems etc., depending upon the subject content.

iii) The pattern of *Semester Examination* question paper is as follows:

1) The duration shall be 3 hours with a maximum of 60 marks.
2) Section-A contains 5 compulsory questions each carrying 2 marks. Only one question is selected from each unit. This section carries 10 marks in total.

3) Section-B contains five questions, one question from each unit with *'either' 'or' choice.* Each question carries ten marks. Based on the necessity each question may contain sub divisions. This section carries 50 marks in total.

8.2 **Laboratory Courses**:

i) All laboratory courses shall be assessed as follows:

Assessment Method	**Marks**
Continuous Assessment	40
Semester Examination (Duration: 3 Hours)	60
Total	100

ii) *Continuous Assessment* shall be based on the regular laboratory exercise and records, internal laboratory test and viva voce.

Regular laboratory exercise and records : 20 marks
Internal laboratory tests : 10 marks
Viva Voce : 10 marks

iii) The *Semester Examination* of the laboratory courses will be evaluated for 60 marks by a panel of examiners comprising of an internal examiner and an external examiner. The Break-up of marks is as follows:

Procedure : 10 marks
Laboratory work and calculations : 40 marks
Viva-Voce : 10 marks

8.3 **Project Work**:

The project work will be evaluated for a total of 600 marks – 200 marks for Phase I and 400 marks for Phase II as detailed below:

Phase I (200 Marks):

Internal Continuous Assessment (Marks)	
Guide	50
First Evaluation	50
Second Evaluation	50
Viva Voce (internal Committee)	50
Total	**200**

Phase II (400 Marks):

Internal Continuous Assessment (Marks)		External Assessment (Marks)	
Guide	100	External Examiner Evaluation	100
First Evaluation	50	Viva Voce (external examiner)	50
Second Evaluation	50	Viva Voce (internal examiner)	50
Total	**200**	**Total**	**200**

Internal evaluation should be done by a committee comprising of three faculty members (other than guide) appointed by the Controller of Examinations.

9. DECLARATION OF RESULTS

9.1 ***Examination Passing Criteria***: A student is declared as ***passed*** in a course if he gets 40% marks and above in the Semester Examination and 50% marks and above overall (*Semester Exam marks and Continuous Assessment marks put together*).

9.2 ***Evaluation of Semester Examination Answer Scripts***: Semester examination answer scripts (theory) will be evaluated independently by two examiners appointed by the Controller of Examinations and if the difference in marks awarded to an answer script by the examiners is less than 15 percent of total marks earmarked for the semester examination, then the average of the marks awarded by the two examiners is taken as the mark scored in the examination. If the difference in marks is greater than 15, then the answer script will be evaluated by a third examiner and the mark awarded by the third examiner is taken as the final score.

9.3 **Result Passing Board**: The Controller of Examinations shall constitute a **Result Passing Board** for M.Sc. programme. The Result Passing Board shall meet soon after the valuation of Semester examination answer scripts to analyze the relative performance of students and award appropriate grace marks, if necessary, for overall improvement in the result. On finalization of the results by Result Passing Board, the Controller of Examinations shall declare the results.

9.4 **Photocopy of the Answer Script and Revaluation**

i) After declaration of results,

1) Photocopy of valued answer scripts with the marks awarded to individual answers shall be made available to the students on submission of application along with prescribed fees to Controller of Examinations.

2) Students can get their answer scripts revalued by submitting an application along with prescribed fees to the Controller of Examinations.
3) The provision for getting the photocopy of valued answer scripts and revaluation is extended to all the students including those who have passed the examination.
4) The Controller of Examinations shall get the answer script revalued by appointing an examiner other than the one who valued the script earlier and revise the grade accordingly.
5) The marks obtained after revaluation will be taken as final irrespective of the marks awarded earlier. That is, if the marks obtained after revaluation happens to be lower than the original marks then '*the lower mark*' will be considered for the award of revised grade.

9.5 ***Grade Card***: On declaration of results, Grade Cards will be issued to the students. The Grade Card will contain the list of courses for that semester, the grades obtained by the student, the GPA and the CGPA.

10. AWARD OF GRADES

10.1 The performance of students in a course is expressed in terms of Letter Grades, each carrying certain Grade Points. A total of Six passing Grades namely S, A, B, C, D and E is awarded. Total marks (*sum of Continuous Assessment and Semester Examination marks*) secured by a student in a course is used for computing his Grade by fitting the mark into the Range of Marks assigned for each Grade shown in table below.

Range of Marks	Letter Grade	Grade Points
90 to 100	S	10
80 to 89	A	9
70 to 79	B	8
60 to 69	C	7
55 to 59	D	6
50 to 54	E	5
0 to 49 (Failed)	F	0

The other Letter Grades that shall be indicated in the Grade Card are as follows:

Criterion Letter	Grade	Grade
Failed to Score Pass Mark in the Subject	F	0
Partial Withdrawal from Semester Examination	W	-
Audited the Course	X	-
Absent for the semester examination	Z	0

‘F’ grade denotes failure in the course, 'W' grade indicates authorized partial withdrawal (vide Regulation 14.2), ‘X’ Grade denotes that the student has audited the course and ‘Z’ grade denotes absent for the Semester Examination.

10.2 Student who has secured ‘F’/‘W’/ ‘Z’ grade shall reappear for the examination in the following semesters. A student who has scored a pass grade cannot reappear for the examination.

10.3 A student securing ‘F’ grade in an elective course may reappear for the examination in the following semester or drop the elective course and subsequently register for another elective course in the following semester in place of the dropped elective course.

10.4 Grade Point Average (GPA) indicates the performance of a student in all the examinations appeared by him in a particular semester. GPA score will appear in all the Semester Examination Grade Cards. The Grade Point Average (GPA) for a particular semester is calculated as the ratio of the sum of the products of the number of Credits of a course (C_i) and the Grade Points scored in that course (GP_i), taken for all the courses, to the sum of the number of credits of all the courses (n) registered in that semester.

$$GPA = \frac{\sum_{1}^{n} C_i GP_i}{\sum_{1}^{n} C_i}$$

where, *n* is the number of courses registered in that semester. For a student who has partially withdrawn from writing examinations of courses in a semester, n is counted as total number of courses appeared in that semester minus the number of courses partially withdrawn.

10. 5 Cumulative Grade Point Average (CGPA) indicates the performance of a student in all the examinations appeared by him up to a particular semester. CGPA score will appear in all the Semester Examination Grade Cards starting from the first semester. The Cumulative Grade Point Average (CGPA) up to a particular semester is calculated as follows:

$$CGPA = \frac{\sum_{1}^{N} C_i GP_i}{\sum_{1}^{N} C_i}$$

where, C_i is the Credit of a course, GP_i is the Grade Point obtained by the student in that course and N is the total number of courses registered up to that semester starting from the first semester. For a student who has partially or completely withdrawn from writing examinations of courses in a semester, N is counted as total number of courses registered up to that semester starting from the first semester minus the number of courses withdrawn.

11. ELIGIBILITY FOR APPEARING FOR SEMESTER EXAMINATION

11.1 There shall be not any adverse report regarding the conduct of the student to be eligible to appear for the semester examination.

11.2 Although 100% overall attendance in all the courses in a semester is desirable, a student should have not less than 75% overall attendance to become eligible to appear for the examination.

11.3 A student, whose overall attendance falls below 75% but 60% and above in a semester, shall be permitted only on medical grounds to appear for semester examination after payment of prescribed condonation fee along with a medical certificate obtained from a medical officer and duly acknowledged by the in-house medical officer of the College.

11.4 A student whose overall attendance in a semester falls below 60% shall not be permitted to appear for the semester examination and shall not be allowed to move to the next semester. A student who is stopped from moving to the higher semester is required to rejoin the course in the same semester in the following academic year.

12. WITHDRAWAL FROM SEMESTER EXAMINATION

12.1 ***Complete Withdrawal***: A student, who is otherwise eligible to appear for the semester examinations, will be permitted to withdraw from appearing for the entire Semester Examination as one unit (*complete withdrawal*) for valid reasons and on the recommendation of the Head of the Department and with the approval of the Dean (Academics). Complete withdrawal application shall be made before the commencement of the first examination pertaining to the semester. Such withdrawal shall be permitted ***only once*** during the entire programme.

12.2 ***Partial Withdrawal:*** If a student falls sick in the middle of the semester examinations, can withdraw from one or more subjects on production of valid medical certificate (*Partial Withdrawal*). The student is permitted to exercise this provision of partial withdrawal from the courses in the middle of the semester examinations ***only once*** in the entire course.

12.3 A student who has partially or completely withdrawn from appearing for semester examinations in a particular semester should appear for the examinations of all the withdrawn subjects in the next semester itself.

12.4 Other conditions being satisfactory, students who withdraw from semester examinations are eligible to be awarded *First Class* with *Distinction* whereas they are not eligible to be awarded a *rank*

12.5 Only a student who has not failed in any subject in all the previous semesters (*eligibility condition for 'First Class with Distinction' classification*) is eligible to opt for the Withdrawal from the semester examinations.

12.6 The provision for withdrawal (complete/partial) is allowed only for second to third semester examinations.

13. TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

A student may be permitted to withdraw temporarily from the programme for medical reasons subject to production of medical certificate. A student after temporary discontinuance may rejoin the programme at the commencement of the semester at which he discontinued. However, the total period for the completion of the course, reckoned from the commencement of the first semester to which the student was admitted, shall not in any case exceed four years (eight continuous semesters), including the period of authorized temporary discontinuance.

14. MOVEMENT TO HIGHER SEMESTERS

14.1 A student can move to the next semester provided he has fulfilled the minimum attendance requirement for appearing for the semester examination (*vide Regulation 11*).

14.2 The student who has failed to fulfill the above conditions will not be permitted to move to the higher semester, and shall rejoin the programme only after a temporary break.

14.3 A student, after the temporary break, will be permitted to rejoin the programme at the appropriate semester along with the regular students at the time of normal commencement of that semester.

14.4 A student who rejoins the programme after the temporary break shall be governed only by the rules, regulations, courses of study and syllabus in force, at the time of his rejoining the course.

15. CLASSIFICATION

After successful completion of the programme, degree will be awarded (*vide Regulation 17)* as per the following classifications based on the final CGPA:

15.1 Students who have successfully completed the programme within four consecutive semesters and obtained a final CGPA of **8.5** or above by passing all the courses in the first appearance will be declared as passed in ***First Class with Distinction***. Students who have obtained 'F' or 'Z' grade in any of the courses in the entire programme and subsequently passed the examinations with a final CGPA of 8.5 or above are not eligible for ***First Class with Distinction*** classification. However, those students who have opted for authorized withdrawal from examination (*vide Regulation 12*) or temporary break of study (*vide Regulation 13*) will be eligible for ***First Class with Distinction*** classification.

15.2 Students who have obtained a final CGPA of **6.5** or above, but below **8.5,** shall be declared to have passed in ***First Class***. Students who have lost the eligibility for ***First Class with Distinction*** classification (by obtaining 'F' or 'Z' grade in any of the courses in the entire programme and subsequently passing the examinations with a final CGPA of 8.5 and above)-are also declared to have passed in ***First Class***.

15.3 Students who have obtained final CGPA below **6.5** will be declared to have passed in ***Second Class***.

15.4 ***Only one Rank (First Rank)*** will be awarded for M.Sc. in the order of merit among the students who are declared to have passed in First Class with Distinction. However, a student who has successfully completed the programme after availing the provision of 'Withdrawal from Examinations' and declared to have passed in First Class with Distinction is not eligible for the award of rank. Separate *Rank Certificate* will be issued to the Rank Holder.

16. CONSOLIDATED GRADE CARD

At the end of the programme, all successful students will be issued a consolidated *Grade Card* which will necessarily contain the following particulars in addition to any other relevant information:

1) Grades in the subjects of all the semesters with month and year of passing
2) CGPA

3) Classification - First class with Distinction / First class / Second class

17. ELIGIBILITY FOR THE AWARD OF DEGREE

A student shall be eligible for the award of the degree of the Master of Science (M. Sc) only if he:

1) has earned the required number of credits specified in the curriculum of the relevant branch of study within the maximum duration prescribed.
2) has no dues to the Institution, Library, Hostels, etc.
3) has no disciplinary action pending against him.

18. EQUIVALENCE

18.1 ***M.Sc (Material Science & Technology)***

The Curriculum and Syllabus of M.Sc (Material Science & Technology) is Equivalent to Two Years Degree Course in M.Sc. (Physics) offered by other recognized Indian Universities.

19. M.Sc. PROGRAMME COMMITTEES

i) M.Sc Programme will have a *M.Sc Programme Committee* comprising of all the faculties offering courses in the programme and two students from the respective class. The M.Sc programme committee will be chaired by the Head of the Department and convened by a M.Sc *Programme Coordinator*. A faculty member in the rank of Professor / Associate Professor who is handling a course in the M.Sc. programme will be designated by the concerned HoD as the M.Sc. programme coordinator for the M.Sc. programme. The HoD will constitute the M.Sc. programme committee for each one of the M.Sc. courses and communicate the same to the Dean(Academics) for information.

ii) It shall be the duty and responsibility of the committee to review periodically the progress of the courses in the programme, discuss the problems concerning the curriculum and syllabi and conduct of classes.

iii) The committee shall make suggestions, if and when necessary, to individual teachers on the assessment procedure for the courses. The committee to bring to the notice of the Head of the Institution any difficulty encountered in the conduct of the classes or any other pertinent matter.

iv) The committee shall meet at least twice a semester and minute the proceedings.

20. ACADEMIC COURSES COMMITTEE

The Academic Courses Committee is an internal academic body constituted by the Principal with Dean (Academics) as Convener, Associate Deans (Academics), Controller of

Examinations and all Heads of the Departments as members. The Convener will chair the meetings of Academic Courses Committee.

The role of the committee is as follows:

1) Discuss and deliberate on the general framework of curriculum and syllabi for various branches of study.
2) Discuss and deliberate on any amendments in the curriculum, syllabi and regulations before placing it in the Board of Studies/Academic Council for approval
3) Approve the consolidated list of Electives offered in an academic year
4) Discuss and deliberate on any other academic matter, on the direction of the Principal

The Academic Courses Committee will meet as and when required. The decisions taken in the meetings of the committee are subject to the approval of the Principal.

21. ACADEMIC APPEALS BOARD

The entire process of Continuous Assessment shall be made transparent, and the course instructor shall explain to a student why he gets whatever marks awarded, if and when required. However, if a student finds some anomaly in the award of marks in the continuous assessment, he can make an appeal to the Academic Appeals Board for review of marks awarded. Before appealing for such review, a student shall first approach the concerned Course Instructor and then the concerned Head of the Department, with a request to do the needful. Only after exhausting the above options and in situations where satisfactory actions / remedial measures have not been taken, the student may appeal to the Academic Appeals Board. The Academic Appeals Board is constituted with Dean (Academics) as convener, Associate Deans (Academics) and one senior level professor as members, and the concerned Head of the Department and any department faculty as co-opted members. The board will receive the grievance/complaints in writing from the aggrieved student regarding anomaly in award of marks. The board will examine the complaints and recommend appropriate measures to the Principal, for necessary action.

ACADEMIC YEAR 2019-20

I SEMESTER

Code No.	Name of the Subjects	Category	Periods/week			Credits	Marks		
			L	T	P		CA	SE	TM
PH251	Mathematical Methods for Physics	TY	3	1	0	4	40	60	100
PH252	Classical and Statistical Mechanics	TY	3	1	0	4	40	60	100
PH253	Materials Science- I	TY	3	1	0	4	40	60	100
CE278	Strength of Materials	TY	3	1	0	4	40	60	100
	Elective I	TY	3	0	0	3	40	60	100
	Elective II	TY	3	0	0	3	40	60	100
CE279	Strength of Materials Laboratory	LB	0	0	3	2	40	60	100
EI296	Instrumentation Laboratory	LB	0	0	3	2	40	60	100
	Total					**26**			**800**

II SEMESTER

Code No.	Name of the Subjects	Category	Periods/week			Credits	Marks		
			L	T	P		CA	SE	TM
PH254	Materials Science- II	TY	3	1	0	4	40	60	100
PH255	Quantum Mechanics	TY	3	1	0	4	40	60	100
CS296	Computer Programming in C	TY	3	1	0	4	40	60	100
	Elective III	TY	3	0	0	3	40	60	100
	Elective IV	TY	3	0	0	3	40	60	100
	Elective V	TY	3	0	0	3	40	60	100
PH256	Materials Science Laboratory-I	LB	0	0	3	2	40	60	100
CS297	Computer Programming Laboratory	LB	0	0	3	2	40	60	100
	Total					**25**			**800**

III SEMESTER

Code No.	Name of the Subjects	Category	Periods/week			Credits	Marks		
			L	T	P		CA	SE	TM
PH257	Nuclear and Particle Physics	TY	4	0	0	4	40	60	100
PH258	Smart Materials	TY	4	0	0	4	40	60	100
PH259	Electromagnetic Theory	TY	3	1	0	4	40	60	100
	Elective VI	TY	3	0	0	3	40	60	100
	Elective VII	TY	3	0	0	3	40	60	100
PH260	Materials Science Laboratory-II	LB	0	0	3	2	40	60	100
ME296	Workshop Practice	LB	0	0	3	2	40	60	100
PH261	Project Phase-I - Seminar	PR	0	0	3	2	200		200
	Total					**24**			**900**

IV SEMESTER

Code No.	Name of the Subjects	Category	Periods/week			Credits	Marks		
			L	T	P		CA	SE	TM
PH262	Project Phase II	PR	0	0	18	12	200	200	400
	Total					**12**			**400**

CA – Continuous Assessment, **SE** – Semester Examination, **TM** – Total Marks

* **TY** – Theory, **LB** – Laboratory, **PR** – Practice

CORE COURSES:

CODE	*SUBJECT*	Category	*Credits*	*Hours*	*Marks*
PH251	Mathematical Methods for Physics	TY	4	4	100
PH 252	Classical and Statistical Mechanics	TY	4	4	100
PH253	Materials Science- I	TY	4	4	100
CE278	*Strength of Materials*	TY	4	4	100
CE279	*Strength of Materials Laboratory*	*LB*	*2*	*3*	*100*
EI296	*Instrumentation Laboratory*	*LB*	*2*	*3*	*100*
PH254	Materials Science- II	TY	4	4	100
PH255	Quantum Mechanics	TY	4	4	100
CS296	*Computer Programming in C*	TY	*4*	*4*	*100*
PH256	Materials Science Laboratory-I	LB	2	3	100
CS297	*Computer Programming Laboratory*	*LB*	*2*	*3*	*100*
PH257	Nuclear and Particle Physics	TY	4	4	100
PH258	Smart Materials	TY	4	4	100
PH259	Electromagnetic Theory	TY	4	4	100
PH260	Materials Science Laboratory-II	LB	2	3	100
ME297	*Workshop Practice*	*LB*	*2*	*3*	*100*
PH261	Project Phase – I	PR	2	3	100
PH262	Project Phase – II	PR	12	18	400

ELECTIVE COURSES:
[Credits = 3 Hours = 3 Marks = 100 **Category = TY]**

PHY52	Analytical Instrumentation
PHY53	Characterisation of Materials
PHY54	Crystal Growth and Characterisation
PHY55	High Pressure Physics
PHY56	Introduction to nano technology
PHY57	Laser Spectroscopy
PHY58	Measurement and Instrumentation
PHY59	Nanomaterials: Preparation and Characterisation
PHY60	Nanoscale Fabrication and Techniques
PHY61	Non Destructive Testing Techniques
PHY62	Semiconductor Device Technology
PHY63	Sensor Technology
PHY64	Solid State Ionics
PHY65	Structure and Properties of Alloys
PHY66	Thermodynamics
CYY51	*Ceramic Materials*
CYY52	*Polymers and Composite Materials*
MEY96	*Metallurgy*
MEY97	*Corrosion Science and Engineering*

Department : PHYSICS			**Programme : M.Sc (Materials Science & Technology)**						
Semester: First			**Category : TY**						
Course Code	**Course Name**		**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
PH251	**MATHEMATICAL METHODS FOR PHYSICS**		**3**	**1**	**0**	**4**	**40**	**60**	**100**
Prerequisite:	-								
	The course will enable the student to:								
Course Objective	**CO1**	Understand the solutions of differential equations							
	CO2	Learn the concepts of algebraic and transcendental equations using matrices							
	CO3	Understand the vector calculus							
	CO4	Study the Fourier analysis and partial differential equations							
	CO5	Solve the problems in complex variables							

UNIT – I	**Differential Equations and Solutions**	**Hours: 12**
Ordinary Differential Equations: - Series solution to second order and higher order Linear differential equations-Forbenius method – series solution to Legendre and Bessel equations, Sturm-Liouville problems, Solution of ODEs using Laplace transforms.		
UNIT – II	**Solving algebraic and transcendental equations using matrices**	**Hours: 12**
Solution of general system of Linear equations by Gauss elimination, Cramer's rule, Gauss-Jordan elimination - Inverse of a matrix by row transformation-cayley-Hamilton theorem- Matrix eigenvalue problems.		
UNIT – III	**Vector Calculus**	**Hours: 12**
Vector Calculus: Vector analysis - Vector and scalar functions and fields - Derivatives, Gradient, Divergence and Curl (their properties and relations) - Vector integral calculus - Line integrals, Surface integrals, Green's theorem, Gauss theorem - Applications, Stoke's theorem.		
UNIT – IV	**Fourier Analysis and partial differential equations**	**Hours: 12**
Fourier analysis and Partial differential equations: Fourier series, Fourier integrals, Fourier transforms; Partial differential equations - Solution of Wave equation by Separation of variables, Fourier series solution of Heat flow equation.		
UNIT – V	**Theory of Complex Variables**	**Hours: 12**
Complex Analysis: Complex numbers and functions, Complex integration- Cauchy's theorem, Cauchy-Reimann equation. Power series, Taylor series, Maclaurin series, Laurent series, Singularities and zeros, Residue integration, Complex analysis applied to potential theory.		

Total contact Hours:45	**Total Tutorials:15**	**Total Practical Classes: 0**	**Total Hours: 60**

Text Books:

1. 1 Erwin Kreyszig, Advanced Engineering Mathematics. 8th ed. John Wiley & Sons, Inc., 1999 (Chapters 1—16).
2. Herbert Kreyszig & Erwin Kreyszig, Students Solution manual - Advanced Engineering, Mathematics 8th ed. John Wiley & Sons, Inc., 2001.
3. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 1998.
4. Gupta, B.D., Mathematical Physics 3rd Edition, Vikas Publishing House Pvt Ltd, 2004

Reference Books:

1. 1 Merle C. Potter & Jack Goldberg, Mathematical Methods. 2nd ed. Prentice Hall of India Pvt Ltd, 1998.
2. K. F. Riley, M. P. Hobson & S. J. Bence, Mathematical Methods for Physics and Engineering. Low

Price ed. Cambridge University Press, 1999. 3. George B. Thomas & Ross L. Finney, Calculus and Anaytic Geometry. 9th ed. (low price) Pearson Education, Inc., 1996. 4. Sadri Hassani, Mathematical Physics - A Modern Introduction to Its Foundations. Springer-Verlag New York, Inc., 1999. 5. Ray C. Wiley & Louis C. Barret, Advanced Engineering Mathematics. 6th ed. Tata McGraw-Hill 2003. 6. R. K. Jain & S. R. K. Iyengar, Advanced Engineering Mathematics. 2nd ed. Narosa Publishing House, 2003. 7. Schaum's outline series; McGraw-Hill Differential Equations, Laplace Transforms, Matrix Operations, Linear Algebra, Fourier Analysis, Partial Differential Equations, Complex Variables, Mathematical Handbook
Web sites: {optional}
1

Department : PHYSICS		Programme : M.Sc (Materials Science & Technology)						
Semester: First		**Category : TY**						
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
PH252	**CLASSICAL AND STATISTICAL MECHANICS**	**3**	**1**	**0**	**4**	**40**	**60**	**100**

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Impart knowledge on the basic principles of Lagrangian, Hamiltonian and transformation of coordinates
	CO2	Study the central force, scattering theory & canonical transformation
	CO3	Impart knowledge on central force, rigid body dynamics and small oscillations
	CO4	Understand and analysis of classical statistics
	CO5	To learn the concepts of quantum statistics to various physical systems

UNIT – I	**Lagrangian and Hamiltonian formulation**	**Hours: 12**

Constraints and their classification, Lagrange's equations of motion of first kind, D'Alembert's principle, generalized coordinates- potentials- momenta and energy, derivation of Lagrange's equations of motion of 2nd kind from D'Alembert's principle, cyclic coordinates and integrals of motion, homogeneity of time and conservation of energy, homogeneity of space and conservation of momentum, Isotropy of space and conservation of angular momentum, derivation of Hamilton's equations of motion using Legendre's dual transformation, configuration space, phase space and state space, principle of least action and Hamilton's principle, derivation of Euler-Lagrange equations of motion from Hamilton's principle.

UNIT – II	**Central force, scattering theory & Canonical transformation**	**Hours: 12**

Inertial forces in the rotating frame, non inertial frames-pseudo forces and Coriolis force, central force: definition and properties, two-body central force problem, center-of-mass and laboratory coordinate systems, collision and scattering: scattering cross section, scattering by a central force: Rutherford formula, canonical transformations: definition-properties and examples, Poisson's bracket: definition and properties, invariance of Poisson bracket under canonical transformation.

UNIT – III	**Rigid body dynamics and Small oscillations**	**Hours: 12**

Derivation of kinetic energy and angular momentum of a rotating rigid body, moment of inertia tensor, transformation of inertia tensor, principal moment of inertia and ellipsoid of inertia, calculation of moment of inertia, Eulerian rotation and Euler angles, Euler's equation of motion for rigid bodies, small oscillations: Types of equilibrium, equations of motion of a coupled system and normal modes

UNIT – IV	**Classical Statistics**	**Hours: 12**

Fundamental concepts of phase space, microstate and ensemble, postulates of classical statistical mechanics, relation between entropy and probability, microcanonical ensemble (MCE), derivation of thermodynamics from MCE, the equipartition theorem (without proof). derivation of classical ideal gas equation using MCE, Gibb's paradox-Sackur-Tetrode equation, Canonical ensemble-introduction and energy fluctuation, partition function for canonical ensemble, calculation of thermodynamic quantities from partition function, derivation of classical ideal gas equation using canonical ensemble.

UNIT – V	**Quantum Statistics**	**Hours: 12**

Introduction to quantum statistics, Maxwell-Boltzmann (MB) statistics-derivation of distribution function, Bose-Einstein (BE) statistics-derivation of distribution function, Fermi-Dirac (FD) statistics-derivation of distribution function, photon statistics and derivation of Plank's distribution law, derivation of Fermi energy of a degenerate Fermi gas, Bose-Einstein condensation, first and second

order phase transitions, critical point.			
Total contact Hours: 45	**Total Tutorials: 15**	**Total Practical Classes:0**	**Total Hours: 60**
Text/ Reference Books:			
1. 1 N. C. Rana and P. S. Joag. Classical Mechanics. Tata McGraw Hill Publishing Company Limited, New Delhi, 1991. 2. H.Goldstein, Classical mechanics, Narosa Publising House, New Delhi, 1989 3. Federick Reif. Fundamentals of Statistical and Thermal Physics (Chapter 9), McGraw Hill, 1985. 4. Kerson Huang. Statistical Mechanics (Chapters 6, 7), John Wiley & Sons, 2nd edition, 1987. 5. M.C.Gupta, Statistical Thermodynamics, Wiley Eastern Ltd., New Delhi, 1993			
Web sites: {optional}			
1			

<table>
<tr><td colspan="2">Department : PHYSICS</td><td colspan="7">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="2">Semester: First</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PH253</td><td>MATERIALS SCIENCE - I</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">-</td></tr>
<tr><td rowspan="6">Course Objective</td><td colspan="8">The course will enable the student to</td></tr>
<tr><td>CO1</td><td colspan="7">Impart some basic knowledge about crystal structure of solids</td></tr>
<tr><td>CO2</td><td colspan="7">Study the electrical properties of metals</td></tr>
<tr><td>CO3</td><td colspan="7">Learn the thermal properties materials</td></tr>
<tr><td>CO4</td><td colspan="7">Understand the band theory of solids</td></tr>
<tr><td>CO5</td><td colspan="7">Study the behaviour of semiconductors</td></tr>
<tr><td>UNIT – I</td><td colspan="4">Crystal structures</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Space group symmetry – Symmetry operations – Point group and Space group symmetry – Crystal structures – chemical binding in solids – Close packed structures – Radius ratio rules – Miller indices – Reciprocal lattice – X-ray diffraction – Atomic scattering factor and structure factor (without rigorous derivation) – interpretation of X-ray diffraction data to determine simple crystal structures – X-ray diffraction experimental methods to determine crystal structure – Laue, rotating single crystal and powder methods – electron and neutron diffraction – X-ray diffraction on Amorphous materials.</td></tr>
<tr><td>UNIT – II</td><td colspan="4">Electrical Properties of Metals</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Classical free electron theory of metals – Drawbacks of Classical theory – Quantum free electron theory – Fermi Dirac Statistic and Electron distribution in solids – Density of energy states and Fermi energy – The Fermi Distribution function – Heat capacity of electron gas – Electron scattering and Sources of Resistance in metals – Electron-scattering mechanisms and Variation of Resistivity with Temperature – Thermal Conductivity in metals.</td></tr>
<tr><td>UNIT – III</td><td colspan="4">Thermal Properties</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Theories of specific heats – Einstein's and Debye's theories – Lattice vibration in one dimensional – mono atomic and diatomic lattices – Phonons – Thermal Conductivity – umklapp process – Thermal expansion – Interaction of phonons with electron, photon and phonon (qualitative ideas) –(Phonon Scattering by neutron diffraction) – Thin films – Preparation and properties.</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">Band Theory of Solids</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Introduction- Formation of Energy Bands in Solids – Band theory of Solids – Kronig Penney model _ Brillouin Zones – motion of electrons in one dimensional periodic potential – Effective mass of electrons – concept of Holes – classification of materials according to Band theory – Fermi Surfaces in metals – Band structure of Semi conductors</td></tr>
<tr><td>UNIT – V</td><td colspan="4">Semiconductors</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Intrinsic Semiconductors – Conductivity and Temperature – Statistics of Electrons and Holes in Intrinsic Semiconductors – Electrical conductivity – Impurity Semiconductors or Extrinsic Semiconductors – Statistics of Extrinsic Semiconductors – Mechanism of current Conduction in semiconductors – mobility of Current carriers - Hall effect – Advantages of Semiconductor Devices – The p-n Junction – Some Special p-n junction Diodes.</td></tr>
<tr><td colspan="2">Total contact Hours: 45</td><td colspan="2">Total Tutorials: 15</td><td colspan="3">Total Practical Classes: 0</td><td colspan="2">Total Hours: 60</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="9">Text Books:
1. Solid State Physics, A.J. Dekkar, Mac Millan Student Ed. , (1986).
2. Introduction to Solid State Physics, S.O.Pillai,Wiley Eastern & Sons – (2005).
3. Charles Kittel, Introduction to solid state physics, Wiley 7th edition, (1996).
4. M.Ali Omar, Elementary Solid State Physics, revised printing Pearson Education (2000)</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Materials Science, J.C. Anderson & KDB Lever, ELBS fifth Edn., (2004).</td></tr>
</table>

2. Electrical Engineering Materials, A. J. Dekker, Prentice Hall, (1983).
3. Physical Properties of Materials, M.C. Lovell etal, ELBS, (1984).
4. Harald Ibach and Hans Lueth, Solid State Physics, 2nd edition Springer (1996)
5. N.W. Ashcroft and N.D. Mermin Solid State Physics, Thomson Asia Pte Ltd, (2003)
8. Introductory Solid State Physics, H.P. Mayers, Viva Book Publishers, New Delhi- 1998.
9. Solid State Physics, J.S. Blackmore, Cambridge University Press, 1985.
10. V.Raghavan, Materials Science and Engineering, Prentice Hall,(2003)

Web sites: {optional}

1

Department : CIVIL ENGINEERING		Programme: M.Sc (Materials Science & Technology)						
Semester: First		Category : TY						
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE278	STRENGTH OF MATERIALS	3	1	-	4	40	60	100
Prerequisite:	-							

	The course will enable the student to	
Course Objective	CO1	Acquire knowledge on the behavior of various materials subjected to stress
	CO2	Acquire knowledge on the stress-strain behavior simple and composite materials/components
	CO3	Understand the behavior of simple components under direct and shear stress
	CO4	Understand the concepts of bending of beams
	CO5	Study the flexural behavior of simple beams

UNIT – I	Behaviour of Materials	Hours: 12
Concept of mechanics of deformable bodies – behavior of mild steel under tension – stress and strain definition – elastic constants and their relationships – equivalent modulus. Stress strain behavior of various materials.		
UNIT – II	Stresses and Strains	Hours: 12
Simple stress and strains of uniform bar, tapered bar – composite members – stress & strain – thermal stress & strain		
UNIT – III	Thin Cylindrical Shells	Hours: 12
Thin cylindrical shells – hoop stress – longitudinal stress – change in dimension due to internal pressure – thick cylindrical shells – Lame’s theory – longitudinal and shear stress		
UNIT – VI	Bending of Beams	Hours: 12
Bending moment and sheering force diagrams for cantilever, simply supported and overhang beams – theory of simple bending – neutral axis – stress distribution across a section due to bending		
UNIT – V	Shear Stress on Beams	Hours: 12
Shear stresses due to bending – stress variation in rectangular beam – combined direct and bending stress on members under axial and flexural loading.		

Total contact Hours: 45	Total Tutorials: 15	Total Practical Classes: -	Total Hours: 60

Text Books:

1. Rajput R K, Strength of Materials, S Chand & Co, New Delhi, 2002
2. Bhavikatti S S, Strength of Materials, Vikas Publishing House (P) Ltd, 2002

Reference Books:

1. Hearn, E.J. Mechanics of Materials, Vols. I & II, Butterworth-Heinemann, Oxford, 2000.

Department Civil Engineering		**Programme : M.Sc (Materials Science & Technology)**						
Semester : First		**Category : LB**						
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
CE279	**STRENGTH OF MATERIALS LABORATORY**	**-**	**-**	**3**	**2**	**60**	**40**	**100**
Prerequisite:	-							

	The course will enable the student to	
Course Objectives	**CO1**	Acquire knowledge on the behavior of various materials subjected to stress
	CO2	Acquire knowledge on the stress-strain behavior simple and composite materials/component
	CO3	Understand the behavior of simple components under direct and shear stress
	CO4	Understand the concepts of bending of beams
	CO5	Study the flexural behavior of simple beams
		Hours: 45

1. Tension test on mild steel & R.T.S rod
2. Tension test on mild steel wire, non ferrous metals and plastics
3. Cold bend test on mild steel rods and flats
4. Impact test on metals (Charpy and Izod's test) and on plastics
5. Rockwell and Brinnels hardness test for ferrous, Non ferrous,, Alloy specimens
6. Determination of spring constant.
7. Compressive strength of cement concrete by Rebound hardness tester
8. Compressive strength evaluation of cement concrete by ultrasonic pulse velocity

Total contact Hours: -0	**Total Tutorials: -0**	**Total Practical Classes: 45**	**Total Hours: 45**

Department : Electronics and Instrumentation Engineering		**Programme : M.Sc (Materials Science & Technology)**							
Semester : First		**Category : LB**							
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**			
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**	
EI296	**INSTRUMENTATION LABORATORY**	**-**	**-**	**3**	**2**	**60**	**40**	**100**	

Prerequisite:	-	
	The course will enable the student to	
Course Objectives	**CO1**	Study characteristics of LVDT
	CO2	Study characteristics of thermocouple temperature
	CO3	Understand the behavior of characteristics of bridges
	CO4	Understand the Calibration of wattmeter and energy meter
	CO5	Learn filters and amplifiers

	1. LVDT 2. Thermocouple and RTD 3. Anderson & Hay's Bridges 4. Maxwell's & Schering Bridges 5. Calibration of wattmeter and energy meter 6. Clippers and clampers 7. Design of Filters 8. Instrumentation amplifiers	**Hours: 45**

Total contact Hours: -	**Total Tutorials: -**	**Total Practical Classes: 45**	**Total Hours: 45**

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<table>
<tr><td colspan="2">Department : PHYSICS</td><td colspan="7">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="2">Semester: Second</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PH254</td><td>MATERIALS SCIENCE - II</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2">-</td></tr>
<tr><td></td><td colspan="2">The course will enable the student to</td></tr>
<tr><td rowspan="5">Course Objective</td><td>CO1</td><td>Impart some knowledge about dielectric polarization</td></tr>
<tr><td>CO2</td><td>Study the optical properties of Materials</td></tr>
<tr><td>CO3</td><td>Understand the magnetic Properties and their applications</td></tr>
<tr><td>CO4</td><td>Learn the types of superconductivity</td></tr>
<tr><td>CO5</td><td>Study the type – II superconductors and its applications</td></tr>
</table>

<table>
<tr><td>UNIT – I</td><td>Dielectric polarization</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Mechanism of Dielectric polarization – Electronic, Ionic and Orientational polarizations – Dielectric strength and Dielectric Breakdown. Lorentz Internal field - Clausius- Mossatti relation – Temperature dependence of static permitivity – Complex permitivity – dielectric loss – frequency dependence of polarization – Experimental determination of dielectric constant and dielectric loss by Scherring Bridge method - Piezo and Pyro electricity- materials and applications– Ferroelectricity – dipole theory of ferroelectrics – ferro electric materials and applications.</td></tr>
<tr><td>UNIT – II</td><td>Optical properties</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Optical constants – absorption of radiation in metals, semiconductors and insulators – edge absorption and excitons (elementary ideas) – Luminescence – Phosphorescence and fluorescence – photoluminescence in semiconductors and insulators – photoconductive devices – solar cells – electroluminescence – LED – Thermally Stimulated Luminescence, Cathodoluminescence- Luminescent materials – ZnS phosphors, Thallium activated alkali halides, Lamp Phosphors</td></tr>
<tr><td>UNIT – III</td><td>Magnetic properties</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Classification of magnetic materials- Dia, Para , Ferro, antiferro and ferrimagnetic materials – domain theory and hysteresis – Weiss molecular field theory and Curie –Weiss law – Quantum mechanical theory for ferromagnetism- Outline of Heisenberg's exchange theory – magnetic anisotropy – Domain walls and Domain theory – Antiferro magnetism- Two sub lattice model- Ferri magnetism – soft and hard magnetic materials , and their applications- metals, alloys and ceramic materials – application of magnetic materials in data storage – magnetic bubble domains.</td></tr>
<tr><td>UNIT – IV</td><td>Superconductivity-I</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Superconductivity – Transition temperature Tc – Critical field Hc- Isotope, pressure, magnetic field effects on Tc – Meissner effect – type I and type II super conductors – London equation – thermodynamics of superconductors – free energy – entropy – specific heat – BCS theory – Superconducting energy gap – DC and AC Josephson effects – Quantisation of flux – Quantum interference</td></tr>
<tr><td>UNIT – V</td><td>Superconductivity II</td><td>Hours: 12</td></tr>
<tr><td colspan="3">High temperature superconductors – copper free oxide superconductors – preparation of Cuprates – Modern theories of HTSc – Qualitative ideas of RVB theory – application of superconductors – High field magnets, motors, generators – Magnetic Levitation and transportation – Nuclear magnetic resonance imaging – energy storage – superconducting power transmission - devises based on Josephson's effect – SQUID – memory elements – Signal Processing.</td></tr>
</table>

Total contact Hours: 45	Total Tutorials: 15	Total Practical Classes: 0	Total Hours: 60

Text Books:

1. Introduction to Solid State Physics, S.O.Pillai, New Age International (2005)
2. Charles Kittel, Introduction to solid state physics, Wiley 7th edition, (1996)

Reference Books:
1. Principles of Solid State Physics, H.V. Keer, Wiley Eastern, (1993). 2. Materials Science, J.C. Anderson & KDB Lever, ELBS fifth Edn., (2004). 3. Physics of Magnetic Semiconductors, E.L. Nagaer, Mir Publishers, (1983). 4. Super conductivity, Mical. Cesnot, World University, Classic, (1992). 5. Electronic Engineering Materials and Devices, J. Allison, Tata Mc Graw Hill, 1985. 6. Solid State Physics, N.W. Ashcroft & N.D Mermin, Thomson Asia, Singapore, (2003) 7. Fundamentals of Solid State Physics, J. Richard Christman, John Wiley& Sons, (1988)
Web sites: {optional}
1

<table>
<tr><td colspan="2">Department : PHYSICS</td><td colspan="8">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="2">Semester: Second</td><td colspan="8">Category : TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PH255</td><td>QUANTUM MECHANICS</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2">-</td></tr>
<tr><td></td><td colspan="2">The course will enable the student to</td></tr>
<tr><td rowspan="5">Course Objective</td><td>CO1</td><td>Impart knowledge on the basic principles of Quantum mechanics involving postulates and application to one dimensional problems</td></tr>
<tr><td>CO2</td><td>Impart knowledge on the understanding of problems with solutions.</td></tr>
<tr><td>CO3</td><td>Understand the Time-Independent Perturbation theory</td></tr>
<tr><td>CO4</td><td>Learn the Time-Dependent Perturbation theory</td></tr>
<tr><td>CO5</td><td>Study the Scattering theory</td></tr>
</table>

<table>
<tr><td>UNIT – I</td><td>INTRODUCTION TO QUANTUM MECHANICS</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Postulates of quantum mechanics-operator formalism-commutation relations-expectation values. Solution of Schroedinger’s wave equation-three dimensional linear harmonic oscillator, one dimensional square well potential, Tunneling through a one dimensional potential barrier</td></tr>
<tr><td>UNIT – II</td><td>PROBLEMS WITH EXACT SOLUTIONS</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Matrix representation of quantum mechanics- application to one dimensional Simple harmonic Oscillator. Angular momentum- commutation relations-Eigen values and eigen functions of angular momentum - Ladder operator method – Matrix representation of angular momentum operators-combination of two angular momenta, Clebsch Gordon Coefficients. Hydrogen atom –solution of Schroedinger’s wave equation for eigen values and eigen functions.</td></tr>
<tr><td>UNIT – III</td><td>TIME-INDEPENDENT PERTURBATION THEORY</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Time independent perturbation theory for non-degenerate and degenerate levels- application to one dimensional anharmonic oscillator, First Order Stark effect in hydrogen, Zeeman effect. Variation method- ground state energy of Helium atom, Heitler-London theory for Hydrogen molecule.</td></tr>
<tr><td>UNIT – IV</td><td>TIME DEPENDENT PERTURBATION THEORY</td><td>Hours: 12</td></tr>
<tr><td colspan="3">First order time dependent perturbation theory – Transition probabilities – Fermi’s Golden rule-Harmonic perturbation-interaction of electromagnetic radiation with matter, Einstein’s coefficients-selection rules for harmonic oscillator and hydrogen atom (without rigorous derivations), Scattering Theory: Scattering cross section –Born’s approximation, scattering by an attractive square well potential</td></tr>
<tr><td>UNIT – V</td><td>SCATTERING THEORY</td><td>Hours: 12</td></tr>
<tr><td colspan="3">Partial wave analysis-phase shifts-low energy scattering – scattering by an attractive square well potential. Identical particles and spin. Relativistic quantum mechanics –Klein Gordan equation-Pauli’s Spin matrices and Dirac matrices.</td></tr>
</table>

<table>
<tr><td>Total contact Hours: 45</td><td>Total Tutorials: 15</td><td>Total Practical Classes: 0</td><td>Total Hours: 60</td></tr>
</table>

Text Books:

1. Quantum Mechanics, G. Aruldhas, Prentice Hall India, (2002)

Reference Books:

1. A Text Book of Quantum Mechanics , P.M. Mathews and K. Venkatesan,Tata McGraw Hill Publishing Co., New Delhi (1985)
2. Quantum Mechanics , 4^{th} Edn, Ajoy Ghatak and S. Lokanathan, MacMillan(1999)
3. Elements of Quantum Mechanics, Michael D. Fayer, (2001)
4. Quantum Mechanics L.I. Schiff, McGraw Hill, (1996)
5. Quantum Mechanics, L.M. Pauling and H. Wilson , McGraw Hill, (1935)
6. Introduction to quantum Mechanics, Dicke and Wittke, Addison Wesley (1963)

7. Introduction to Quantum Mechanics, Ajoy Ghatak, MacMillan India, (1996)
8. Quantum Mechanics, 7th Edn., S.L.Gupta, V. Kumar,H.V. Sharma and R.C. Sharma, Jai Prakash Natt & Co, Meerut, (1987)
9. Quantum Mechanics, L. Powell and Crasemann, Narosa Publishing House, (1988)

Web sites: {optional}

1

Department : COMPUTER SCIENCE and ENGINEERING		**Programme : M.Sc (Materials Science & Technology)**						
Semester: Second		**Category : TY**						
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
CS296	**COMPUTER PROGRAMMING IN C**	**3**	**1**	**0**	**4**	**40**	**60**	**100**
Prerequisite:	-							

	The course will enable the student to	
Course Objective	**CO1**	Introduce the basic of C language
	CO2	Impart programming skills in C language
	CO3	Identify the pointers and arrays
	CO4	Execute and compile the files
	CO5	Educate problem solving technique

UNIT – I | **Introduction to C language** | **Hours: 12**

Introduction and Importance of C language – Basic structure of C programs – Data types – Constants – Variables – Operators – Arithmetic operators – Precedence of arithmetic operators – Type conversions in expressions – Operator precedence and associativity.

UNIT – II | **Programming language** | **Hours: 12**

Control statements – if- else, switch –case, loop statements – for loop, while loop, do-while – Control breaking statements: break, continue and goto – Functions and program structures – Types of functions – return statement – Actual and formal arguments – Recursive functions Local and global variables – Scope of Variables – Automatic, register – static – external. Preprocessors – Macros and standard functions.

UNIT – III | **Arrays and functions** | **Hours: 12**

Arrays – Introduction – One-dimensional arrays – Two-dimensional arrays – initializing two-dimensional arrays – Multidimensional arrays.
Pointers – understanding pointers – Pointer expressions – Pointers and arrays – Pointers and Character Strings – Pointers and functions – Pointers and structures – Points on pointers

UNIT – IV | **Input and Output operations** | **Hours: 12**

File management in C – Defining and opening a file – Closing a file – Input/ Output operations on files – Error handling during I/O operations – Random access to files – Command line arguments – Dynamic memory allocations.

UNIT – V | **Numerical solutions** | **Hours: 12**

Numerical analysis – Symbolic manipulation – Minimization and maximization of a function – root finding – set of linear algebraic equation – Numeric solutions – collection and analysis of data – Error, accuracy and stability – Modeling of data – least square fitting – non linear fitting – fitting of data to a straight line data with error in both the co-ordinates. Problems solving using packages (Matlab & Mathematica).
Introduction to simulation – methods – deterministic and stochastic – construction of a model – calculation and analysis of physical properties using the model - Application

- Motion of a falling object (force and distance calculations)
- Nuclear decay (mass and energy)
- Bohr atom model (energy eigenvalues)
- Classical and Quantum linear harmonic Oscillators (Non- linearity)

Total contact Hours: 45	**Total Tutorials: 15**	**Total Practical Classes: 0**	**Total Hours: 60**

Text Books:

1. J. B. Dixit, "Computer Fundamentals and Programming in C", Firewall Media, 2009.
2. Balagurusamy. E, "Programming in ANSI C", Tata McGraw Hill, Sixth edition, 2012.

Text/Reference Books:
1. Working with C – Yashavant Kanethkar, BPB, New Delhi – 1994. 2. Ashok N Kamthane, “Computer Programming”, Pearson education, Second Impression, 2008. 3. Venugopal.K and Kavichithra.C, “Computer Programming”, New Age International Publishers, First Edition, 2007.
Web sites: {optional}
1

Department : Physics		**Programme : M.Sc (Materials Science & Technology)**							
Semester : Second		**Category : LB**							
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**			
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**	
PH256	**Materials Science Laboratory-I**	**-**	**-**	**3**	**2**	**60**	**40**	**100**	
Prerequisite:	-								
	The course will enable the student to								
Course Objectives	**CO1**	Gain practical knowledge about diodes							
	CO2	Understand the magnetic, electric, dielectric properties through practice							
	CO3	Study the elastic constants of few materials							
	CO4	Gain practical knowledge using laser experiments							
	CO5	Impart knowledge in ultrasonic NDT							

Hours: 45

1. Determination Band Gap of Semiconductor – Reverse biased PN Junction Diode
2. Hall effect – Hall Coefficient & Mobility
3. Magnetic Susceptibility of liquids - Quincke's method
4. Thermister Characteristics
5. Laser Experiments – Wavelength and Particle Size Determination
6. Electrical Conductivity of Electrolytes using Conductivity Meter
7. Dielectric Constant of liquids using Capacitance Meter
8. Guoy Balance – Determination Paramagnetic Susceptibility.
9. Determination of elastic constants – Hyperbolic fringes/ Elliptical fringes
10. Determination of dielectric constant of ADP and KDP Crystals
11. Ultrasonic Diffractometer - Ultrasonic velocity in liquids
12. Study of crystal lattices – Using Space Lattice kit and Models
13. Strain gauge meter – Determination of Young's modulus of a Beam
14. Resistivity of Metal, Semiconductor and Oxide – Comparative Study
15. NDT – Ultrasonic flaw detector

[Any TEN experiments are to be performed by the students]

Total contact Hours: -	**Total Tutorials: -**	**Total Practical Classes: 45**	**Total Hours: 45**

<table>
<tr><td colspan="2">Department : Computer Science and Engineering/ Information Technology</td><td colspan="8">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="2">Semester : Second</td><td colspan="8">Category : LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CS297</td><td>Computer Programming Laboratory</td><td>-</td><td>-</td><td>3</td><td>2</td><td>60</td><td>40</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">-</td></tr>
<tr><td></td><td colspan="8">The course will enable the student to</td></tr>
<tr><td rowspan="5">Course Objectives</td><td>CO1</td><td colspan="7">Gain hands on experience of compilation and execution C - language</td></tr>
<tr><td>CO2</td><td colspan="7">Understand the concepts of matrix through C - language</td></tr>
<tr><td>CO3</td><td colspan="7">Study the iteration and Binary ASCII</td></tr>
<tr><td>CO4</td><td colspan="7">Inculcate logical and practical thinking towards numerical methods and computer program</td></tr>
<tr><td>CO5</td><td colspan="7">Impart knowledge in advanced graphics</td></tr>
<tr><td></td><td colspan="6">C – Language

1. Sine series
2. Binomial coefficients
3. Transpose of a given matrix
4. Inverse of a given matrix
5. Diagonalisation of a matrix
6. Newton-Raphson method and other iteration methods
7. Reading of data from Binary ASCII to data file – Elementary graphics and plotting
8. Curve fitting – least square, non least square
9. Numerical integration, Trapezoidal rule and Simpson’s rule
10. Bisector
11. Solution of Ordinary differential equation Range – Kutta method
12. Advanced graphics: Ellipse, circle and colour filling.</td><td colspan="2">Hours: 45</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>Total contact Hours: -</td><td>Total Tutorials: -</td><td colspan="4">Total Practical Classes: 45</td><td colspan="3">Total Hours: 45</td></tr>
</table>

Department : PHYSICS		**Programme : M.Sc (Materials Science & Technology)**						
Semester: Third		**Category : TY**						
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
PH257	**NUCLEAR AND PARTICLE PHYSICS**	**4**	**0**	**0**	**4**	**40**	**60**	**100**

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Provide basic nuclear properties and models
	CO2	Understand nuclear forces and disintegration
	CO3	Study the reactions mechanism in nuclear reactions
	CO4	Impart the nuclear fission and reactors
	CO5	Learn the nuclear elementary particles

UNIT – I	**Basic Nuclear Properties and models**	**Hours: 12**

Size, shape, Nuclear radii, Charge distribution, spin and parity, electric and magnetic moment, Binding energy, Weizacker semi-empirical formula, evidence of shell structure, single-particle shell model, its validity and limitations- liquid drop model-Fermi gas model.

UNIT – II	**Nuclear Forces and Nuclear Disintegration**	**Hours: 12**

Classification of fundamental forces- nature of nuclear force, form of nucleon-nucleon potential, charge independence and charge symmetry of nuclear forces, isospin, non central forces and exchange forces- elementary ideas of α, β and γ-decays, Gamow's theory - Fermi theory, selection rules, Nuclear isomerism, ground state of deuteron - n-p scattering- p-p scattering - Partial wave analysis.

UNIT – III	**Nuclear Reactions**	**Hours: 12**

Types of nuclear reactions, -reaction mechanism- compound nuclei and direct reactions –yield and nuclear reaction – Breit – Wigner formula –thermonuclear reaction- hydrogen fusion reactions- Neutron Diffusion theory – Neutron leakage – diffusion and slowing down length- Slowing down of neutrons, Fermiage theory – microscopic and macroscopic cross section.

UNIT – IV	**Nuclear Fission and Nuclear Reactors**	**Hours: 12**

Nuclear fission, fission energy- fission cross section, fission neutrons, chain reaction, multiplication factors- four factor formula- Classification of nuclear reactors – PWR, BWR, BHWR, FBTR-reactor materials (fuel, moderators, coolant and control materials).

UNIT – V	**Elementary Particles**	**Hours: 12**

Quarks, baryons, mesons and leptons, quark model, spin and parity assignments- strangeness- Gellman Nishijima formula - quantum chromo dynamics (QCD), C, P, and T invariance (NCP & CPT invariance) and application & symmetry arguments to particle reactions, symmetry,- unitary symmetry SU(2) – SU(3) - parity non-conversation in weak interaction-relativistic kinematics.

Total contact Hours: 60	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 60**

Text/ Reference Books:

1. Introductory Nuclear Physics, Samuel S. M. Wong (2nd edition) willey –Interscience (1999).
2. Introductory Nuclear theory, L.R.B.Elton, pitman & son (1970)
3. Nuclear Physics, Irwing Kaplan ,Narosa book distributors (2002) 2nd Edition
4. Introduction to Elementary Partical Physics, Alessandro Bettini Cambridg University (2008).
5. Introduction to elementary particles 2nd ed. Wiley –VCH, Germany (2008). Introductory Nuclear Physics, Samuel S. M. Wong (2nd edition) willey –Interscience (1999).
6. Introductory Nuclear theory, L.R.B.Elton, pitman & son (1970)
7. Nuclear Physics, Irwing Kaplan ,Narosa book distributors (2002) 2nd Edition
8. Introduction to Elementary Partical Physics, Alessandro Bettini Cambridg University (2008).
9. Introduction to elementary particles 2nd ed. Wiley –VCH, Germany (2008).

Web sites: {optional}
1

Department : PHYSICS		Programme : M.Sc (Materials Science & Technology)						
Semester: Third		Category : TY						
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
PH258	SMART MATERIALS	4	0	0	4	40	60	100
Prerequisite:	-							

	The course will enable the student to	
Course Objective	CO1	Understand smart materials perspective
	CO2	Impart basic knowledge on smart materials
	CO3	Study the electro-rheological fluid smart materials
	CO4	Learn the Piezoelectric Smart Materials
	CO5	Study different types of shape memory alloys and their applications

UNIT – I | **Introduction And Historical Perspective** | **Hours: 12**

Classes of materials and their usage – Intelligent /Smart materials – Structural materials – Functional materials – Poly-functional materials – Generation of smart materials – Diverse areas of intelligent materials – Primitive functions of intelligent materials – Intelligence inherent in materials – Examples of intelligent materials, structural materials, Electrical materials, bio-compatible materials etc. – Intelligent biological materials – Biomimetics – Wolff's law – Technological applications of Intelligent materials.

UNIT – II | **Smart Materials And Structural Systems** | **Hours: 12**

The principal ingredients of smart materials – Thermal materials – Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – An algorithm for synthesizing a smart material – Passive sensory smart structures–Reactive actuator based smart structures – Active sensing and reactive smart structures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.

UNIT – III | **Electro-Rheological Fluid Smart Materials** | **Hours: 12**

Suspensions and electro-rheological fluids – Bingham-body model – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological fluids – The electro-rheological phenomenon – Charge migration mechanism for the dispersed phase – Electro-rheological fluid domain – Electrorheological fluid actuators – Electro-rheological fluid design parameter – Applications of Electrorheolgoical fluids.

UNIT – IV | **Piezoelectric Smart Materials** | **Hours: 12**

Background – Electrostriction – Pyroelectricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – smart composite laminate with embedded piezoelectric actuators – SAW filters.

UNIT – V | **Shape – Memory Alloy Smart Materials** | **Hours: 12**

Background on shape – memory alloys (SMA)- Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitic transformations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fastners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robot actuated by SMA – SMA memorisation process (Satellite antenna applications) SMA blood clot filter – Impediments to applications of SMA – SMA plastics – primary molding – secondary molding – Potential applications of SMA plastics.

Total contact Hours: 60	Total Tutorials: 0	Total Practical Classes:0	Total Hours: 60

Text/ References:

1. M.V.Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 1992
2. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman, Engineering aspects of Shape Memory

alloys, Butterworth –Heinemann, 1990 C.A.Rogers, Smart Materials, Structures and Mathematical issues, Technomic Publising Co., USA, 1989.
Web sites: {optional}
1

Department : PHYSICS	**Programme : M.Sc (Materials Science & Technology)**
Semester:Third	**Category : TY**

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
PH259	ELECTROMAGNETIC THEORY	3	1	0	4	40	60	100

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Understand electric field and potential
	CO2	Impart knowledge in Boundary value problems & special techniques
	CO3	Study the magnetostatics and related applications
	CO4	Learn the electrodynamics
	CO5	Gain knowledge in Potentials and Radiation

UNIT – I | **Electrostatics** | **Hours: 12**

The electric field – divergence and curl of electrostatic fields, Electric potential – Poisson's and Laplace's equations, Work and Energy in electrostatics, Conductors, Electric fields in matter – Polarization, the field of a Polarized object, the electric displacement, linear dielectrics

UNIT – II | **Boundary value problems & Special techniques** | **Hours: 12**

Laplace's equation in one, two and three dimensions, uniqueness theorems (without proof), the method of images, separation of variables – Cartesian and spherical coordinates, Multipole expansion, the electric field of a dipole.

UNIT – III | **Magnetostatics** | **Hours: 12**

The Lorentz force law and the Biot-Savart law, The divergence and curl of B, Magnetic vector potential, Magnetic fields in matter - Magnetization, the field of a magnetized object – bound currents and physical interpretation, Ampère's law in magnetized materials and the auxiliary field H, linear and nonlinear media – magnetic susceptibility and permeability.

UNIT – IV | **Electrodynamics** | **Hours: 12**

Electromotive force, Electromagnetic induction, Maxwell's equations, The continuity equation, Pounting's theorem (without proof), Electromagnetic waves in vacuum – the wave equation for E and B, Energy and momentum in electromagnetic waves

UNIT – V | **Potentials and Radiation** | **Hours: 12**

Potential formulation, Gauge transformations, Coulomb and Lorentz gauge, retarded potentials of continuous charge distribution, retarded potentials of point charges, Li´enard-Wiechert potential, electric dipole radiation.

Total contact Hours: 45	**Total Tutorials: 15**	**Total Practical Classes: 0**	**Total Hours: 60**

Text Books:

1. Griffiths D J (1999). Introduction to electrodynamics. Prentice Hall of India Private Limited, New Delhi, 3rd edn. (Chapters 2 – 7, selected topics from chapters 8, 9, 10 11.)

Reference Books:

1. E.F,Jordan and K.G.Belmain, Electromagnetic waves and Radiating Systems - Prentice-Hall of India Pvt. Ltd., New Delhi, 1982.
2. D.R.Corson and Paul Lorrain, Introduction to Electromagnetic fields and waves, D.B. Taraporevale Sons & Co. Pvt. Ltd., Bombay, 1970.

Web sites: {optional}

1

Department : Physics			Programme : M.Sc (Materials Science & Technology)						
Semester : Third			Category : LB						
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
PH260	Materials Science Laboratory-II		-	-	3	2	60	40	100
Prerequisite:	-								
	The course will enable the student to								
Course Objectives	CO1	Gain practical knowledge about semiconductors							
	CO2	Understand the thermal properties							
	CO3	Study the electric, dielectric and magnetic properties							
	CO4	Gain practical knowledge using light experiments							
	CO5	Impart knowledge in structural studies							

Hours: 45

1. Band gap determination of P-type/ n-type semiconducting wafer (four probe method)
2. Thermolunimescence study of Alkali Halides
3. Determination of Specific Charge of an Electron (e/m Thomson's method)
4. Determination of Absorption coefficient of air and aluminum using GM counter.
5. Error Analysis
6. Differential Thermal Analysis
7. Dielectric Constant of a Crystal– Frequency Variation using LCR Meter
8. Electrical conductivity study of solids (ionic / semiconducting) using two probe.
9. Magnetic susceptibility of Ferro fluids
10. Determination of wave length of laser – Using Reflection & Transmission Grating
11. Determination of wavelength of Hydrogen Arc spectrum using constant deviation spectrometer.
12. Determination of coefficient of viscosity of Ferro fluids using Spindle Viscometer
13. X -ray powder method – indexing and cell determination
14. Preparation of buffer solutions and pH measurements.
15. Fermi Surface/ DOS of simple elements by *ab initio* calculations

[Any TEN experiments are to be performed by the students]

Total contact Hours: -	Total Tutorials: -	Total Practical Classes: 45	Total Hours: 45

Department : Mechanical Engineering			**Programme : M.Sc (Materials Science & Technology)**						
Semester : Third			**Category : LB**						
Course Code	**Course Name**		**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
ME296	**WORKSHOP PRACTICE**		**-**	**-**	**3**	**2**	**60**	**40**	**100**
Prerequisite:	-								
	The course will enable the student to								
Course Objectives	**CO1**	Convey the basics of mechanical tools used in engineering							
	CO2	Establish hands on experience on the working tools							
	CO3	Develop basic joints and fittings using the hand tools							
	CO4	Establish the importance of joints and fitting in engineering applications							
	CO5	Develop an intuitive understanding of underlying physical mechanism							
									Hours: 45

Fitting Shop:

Study of hand tools like files, chisels, hammers, try square, calipers, hacksaw, marking gauge, punches, tapes, dies etc. use of vernier calipers and micrometers. Use of tools – cutting and filing of M.S. Strips to correct profiles – drilling and tapping

Welding Shop:

Study of welding, soldering and brazing making of lab, butt, of M.S. flats by gas and arc welding. Elementary practice of soldering and brazing (demonstration)

Metal Cutting:

Sand moulding exercises – two box types – demonstration – molten metal pouring and casting. Metal cutting – exercises on lathes – turning, joining, drilling and taper turning.

Total contact Hours: -0	**Total Tutorials: -0**	**Total Practical Classes: 45**	**Total Hours: 45**

<table>
<tr><td colspan="2">Department : PHYSICS</td><td colspan="8">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="10">Semester:</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PHY52</td><td>ANALYTICAL INSTRUMENTATION</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9">-</td></tr>
</table>

	The course will enable the student to	
Course Objective	**CO1**	Introduction to spectroscopy
	CO2	Study the instrumentation of infrared and NMR Spectroscopy
	CO3	Impart knowledge on various spectroscopic methods for surface analysis
	CO4	Learn the concepts of mass spectroscopy and radio chemical methods
	CO5	Analyse the thermal methods

UNIT – I | **Introduction to Spectroscopy** | **Hours: 9**

Basic concepts of Absorption and emission spectroscopy – representation of spectra – basic elements of practical spectroscopy – signal to noise ratio - hardware and software techniques for signal to noise enhancement – resolving power – Fourier transform spectroscopy – evaluation of results – basic principles, instrumentation and applications of atomic absorption, atomic fluorescence and atomic emission spectroscopy – ICP atomic fluorescence spectroscopy.

UNIT – II | **Infrared and NMR Spectroscopy** | **Hours: 9**

Infrared spectroscopy – correlation of IR Spectra with molecular structure, instrumentation, samplings technique and quantitative analysis. Raman Spectroscopy – Classical and Quantum theory instrumentation, Structural analysis and quantitative analysis.

Nuclear magnetic resonance spectroscopy – pulsed Fourier transform NMR spectrometer – elucidation of NMR spectra and quantitative analysis : Electron Spin Resonance Spectroscopy –

UNIT – III | **Spectroscopy for Surface Studies** | **Hours: 9**

Surface study – x-ray emission spectroscopy (XES), electron spectroscopy for chemical analysis (ESCA) - UV photo electron spectroscopy (UPS) - X- ray photo electron spectroscopy (XPS) - Auger emission Spectroscopy (AES) - Transmission Electron microscopy (TEM) - Scanning Electron microscopy (SEM), Surface tunneling microscopy (STEM) - Atomic force microscopy (AFM).

UNIT – IV | **Mass Spectroscopy and Radio Chemical methods** | **Hours: 9**

Mass spectroscopy – Ionization methods in mass spectroscopy – mass analyzer – ion collection systems, correlation of molecular spectra with molecular structure. Instrumentation design and application of Fourier transform mass spectroscopy (FT-MS). Inductively coupled plasma mass spectroscopy (ICP-MS), Secondary Ion Mass Spectroscopy (SIMS) and Ion microprobe mass analyzer (IMMA).

Radio chemical methods – Activation analysis, isotope dilution analysis. Liquid scintillation system. Application of Radionuclides.

UNIT – V | **Thermal Analysis** | **Hours: 9**

Thermal analysis: principles and instrumentations of thermogravimetry (TG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), evolved gas detection, thermo mechanical analysis, dynamic mechanical analysis, Thermometric titrimetry and direct – injection enthalpimetry.

Total contact Hours: 45	**Total Tutorials:**	**Total Practical Classes:**	**Total Hours: 45**

Text Books:

1. Instrumental methods of Analysis, Willard, Merritt, Dean and Settle, CBS Publishers and distributors, New Delhi, 7th edition, 1986.
2. Fundamentals of Molecular Spectroscopy, C.N Banwell and E.M. Mc Cash, Tata Mc Graw Hill, New

Delhi, 1994. 3. Electron Beam Analysis of Materials, M.H. Loretto, Chapman and Hall, 1984. 4. Introduction to Mass Spectrometry, J.T. Watson, Raven, New York 1985. 5. Thermal Methods of Analysis, W. Wendlandt, John Wiley, New York, 1986.
Reference Books:
1. Surface Physics, m. Prutton, Clarenden press, Oxford, 1975. 2. Transmission Electron Microscopy of Materials, G. Thomas, J.G. Michael, John Wiley and Sons, 1979. 3. Instrumental methods in Chemical Analysis, Wing GW, Mc Graw Hill, 1975.
Web sites: {optional}
1

Department : **PHYSICS**			Programme : M.Sc (Materials Science & Technology)						
Semester:			**Category : TY**						
Course Code	**Course Name**		**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
PHY53	***CHARACTERISATON OF MATERIALS***		3	0	0	3	40	60	100
Prerequisite:	-								
	The course will enable the student to								
Course Objective	**CO1**	Understand the concepts of principle and working of thermal methods							
	CO2	Study the various microscopic methods							
	CO3	Impart knowledge on electron microscopy and optical characterisation							
	CO4	Learn the electrical methods							
	CO5	Gain knowledge on spectroscopic instruments							

UNIT – I	**THERMAL ANALYSIS**	**Hours: 9**
Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves - differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters .		
UNIT – II	**MICROSCOPIC METHODS**	**Hours: 9**
Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy -differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - scanning probe microscopy (STM, AFM) - scanning new field optical microscopy - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.		
UNIT – III	**ELECTRON MICROSCOPY AND OPTICAL CHARACTERISATION**	**Hours: 9**
SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation – data collection, processing and analysis- Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.		
UNIT – IV	**ELECTRICAL METHODS**	**Hours: 9**
Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations.		
UNIT – V	**SPECTROSCOPIC INSTRUMENTS**	**Hours: 9**
Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis-application.		

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text/ Reference Books:

1. Stradling, R.A; Klipstain, P.C; Growth and Characterization of semiconductors, Adam Hilger, Bristol,1990.

2. Belk, J.A; Electron microscopy and microanalysis of crystalline materials, Applied Science Publishers, London, 1979.
3. Lawrence E.Murr, Electron and Ion microscopy and Microanalysis principles and Applications, Marcel Dekker Inc., New York, 1991
4. D.Kealey & P.J.Haines, Analytical Chemistry, Viva Books Private Limited, New Delhi 2002.
5. Instrumental methods of Analysis, Willard, Merritt, Dean and Settle, CBS Publishers and distributors, New Delhi, 7th edition, 1986.

Web sites: {optional}

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<table>
<tr><td colspan="2">Department : PHYSICS</td><td colspan="8">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="2">Semester:</td><td colspan="8">Category : TY</td></tr>
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<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PHY54</td><td>CRYSTAL GROWTH AND CHARACTERISATION</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
</table>

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Introduce methods for materials purification
	CO2	Learn growth of single crystals
	CO3	Study the growth kinetics
	CO4	Impart knowledge in crystal growth techniques
	CO5	Understand the crystal characterization

UNIT – I | **Materials Purification** | **Hours: 9**

Distillation, Sublimation, Precipitation – liquid – liquid extraction, ion exchange, gas and liquid chromatography and Zone melting.

UNIT – II | **Growth of Single Crystals** | **Hours: 9**

Classification of growth processes, equilibria in Crystal growth – mono component solid state equlibria. The distribution coefficient phase diagrams, conservative and non conservative processes. Constitutional supercooling.

UNIT – III | **Growth Kinetics** | **Hours: 9**

Driving force, crystal morphology, possible types of interfaces. Nucleation – critical size of homogeneous and heterogeneous nuclei, rate of homogeneous nucleation, growth of solid – atomic mechanism, growth rate on diffuse interface and faceted interface.

UNIT – IV | **Crystal Growth Techniques** | **Hours: 9**

Solid state equilibria: Strain and annealing, Sintering and polymorphic transition – Solid State Equilibria : Bridgmann- Stockbarger technique, Czochralski and Kyropolous – Zone melting and other crucible less techniques. Dendrite growth. – Vapour Solid Equilibria: Sublimation – condensation, sputtering, growth by irreversible reactions – Growth from solution: aqueous-solution growth, Hydro-thermal growth and molten salt growth – Gel growth.

UNIT – V | **Crystal Characterization** | **Hours: 9**

Review of crystal systems – orientations and planes. Orientation of crystals by optical and x-ray methods. Crystal cutting and polishing. Observation of defects in crystals (optical microscopy). Thermal , optical and mechanical properties of crystals (qualitative study).

Total contact Hours: 45	Total Tutorials: 0	Total Practical Classes: 0	Total Hours: 45

Text Books:

1. The Growth of Single Crystals, Laudise, R.A., Prentice Hall, 1970.
2. The Growth of Single Crystals from Liquids, J.C. Brice, North Holland, 1973.
3. Crystal Technology, W.L. Bond, John Wiley & Sons, New York, 1976.

Reference Books:

1. Instrumental Methods in Chemical Analysis, G.W. Wing, McGraw Hill Co., 1975.
2. Crystal Growth and Characteristation, R. Veda and J.B. Mullin (ed), North Hill, 1975.
3. Physical and Chemical Methods of Separation, Eugence W. Berg, Mc Graw Hill Co., 1963.
4. Methods of Experimental Physics, Marton L., (ed) Vol. 64, Academic Press 1959.
5. Phase Transformations in Meterials, Jain, A.K. and Chaturvedi, Prentice Hall, 1972.

Web sites: {optional}

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<table>
<tr><td colspan="2">Department : PHYSICS</td><td colspan="7">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="2">Semester:</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PHY55</td><td>HIGH PRESSURE PHYSICS</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">-</td></tr>
<tr><td rowspan="6">Course Objective</td><td colspan="8">The course will enable the student to</td></tr>
<tr><td>CO1</td><td colspan="7">Study methods of producing high pressure</td></tr>
<tr><td>CO2</td><td colspan="7">Learn measurement of high pressure</td></tr>
<tr><td>CO3</td><td colspan="7">Study the high pressure devices for various applications</td></tr>
<tr><td>CO4</td><td colspan="7">Impart knowledge in high pressure physical properties</td></tr>
<tr><td>CO5</td><td colspan="7">Understand the mechanical properties under pressure</td></tr>
<tr><td>UNIT – I</td><td colspan="4">METHODS OF PRODUCING HIGH PRESSURE</td><td colspan="4">Hours: 9</td></tr>
<tr><td colspan="9">Definition of pressure – Hydrostaticity – generation of static pressure, pressure units – piston cylinder – Bridgmann Anvil – Multi-anvil devices – Diamond anvil cell.</td></tr>
<tr><td>UNIT – II</td><td colspan="4">MEASUREMENT OF HIGH PRESSURE</td><td colspan="4">Hours: 9</td></tr>
<tr><td colspan="9">Primary gauge – Secondary gauge – Merits and demerits – Thermocouple pressure gauge – Resistance gauge – fixed point pressure scale – Ruby fluorescence – Equation of state.</td></tr>
<tr><td>UNIT – III</td><td colspan="4">HIGH PRESSURE DEVICES FOR VARIOUS APPLICATIONS</td><td colspan="4">Hours: 9</td></tr>
<tr><td colspan="9">X-Ray diffraction, Neutron diffraction – Optical studies – Electrical studies – Magnetic studies – High and low temperature applications – Ultra high pressure anvil devices</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">HIGH PRESSURE PHYSICAL PROPERTIES</td><td colspan="4">Hours: 9</td></tr>
<tr><td colspan="9">PVT Relation in fluids – Compressibilities of solids – properties of gases under pressure - Melting phenomena – viscosity – thermo emf – thermal conductivity. Electrical conductivity – phase transitions phonons superconductivity – Electronic structure of metals and semiconductors – NMR and magnetic properties. Liquid crystals – spectroscopy studies –Infrared, Raman Optical absorption – EXAFS.</td></tr>
<tr><td>UNIT – V</td><td colspan="4">MECHANICAL PROPERTIES UNDER PRESSURE</td><td colspan="4">Hours: 9</td></tr>
<tr><td colspan="9">Elastic constants – Measurements – mechanical properties – Tension and compression – Fatigue – Creep – Hydrostatic extrusion. Material synthesis – Superhard materials – Diamond – Oxides and other compounds – water jet.</td></tr>
<tr><td colspan="2">Total contact Hours: 45</td><td colspan="2">Total Tutorials:</td><td colspan="3">Total Practical Classes:</td><td colspan="2">Total Hours: 45</td></tr>
<tr><td colspan="9">Text/ Reference Books:</td></tr>
<tr><td colspan="9">1. The Physics of High Pressure, P.W. Bridgemann, G.Bell and Sons Ltd, London 1931.
2. High Pressure Science and Technology, Vol. I&II, B. Vodar and Ph. Marteam, Pergamom Press, Oxford, 1980.
3. Mechanical Behaviour of Materials under Pressure, H. L.D. Pugh, Elsevier Pub. Co. Ltd., N Y, 1970.
4. Solid State Physics, Vol. 13, 17 and 19, Frederick and Turnbull, Academic Press, New York, 1962.
5. M.I. Eremets, High-pressure Experimental methods, New York, 1996.</td></tr>
<tr><td colspan="9">Web sites: {optional}</td></tr>
<tr><td colspan="9">1</td></tr>
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Department : PHYSICS		**Programme : M.Sc (Materials Science & Technology)**							
Semester:		**Category : TY**							
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**			
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**	
PHY56	**INTRODUCTION TO NANOTECHNOLOGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**	
Prerequisite:	-								

	The course will enable the student to	
Course Objective	**CO1**	Study the nanoscale systems
	CO2	Learn quantum dots and its applications
	CO3	Understand the synthesis of nanostructure materials**:**
	CO4	Study the characterization technique
	CO5	Gain the knowledge in applications of nanptechnology

UNIT – I | **NANOSCALE SYSTEMS**: | **Hours: 9**

Length, energy, and time scales - Quantum confinement of electrons in semiconductor nanostructures: Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Landauer-Buttiker formalism for conduction in confined geometries - Top down and Bottom up approach

UNIT – II | **QUANTUM DOTS:** | **Hours: 9**

Excitons and excitonic Bohr radius – difference between nanoparticles and quantum dots - Preparation through colloidal methods - Epitaxial methods- MOCVD and MBE growth of quantum dots - current-voltage characteristics - magneto tunneling measurements - spectroscopy of Quantum Dots: Absorption and emission spectra - photo luminescence spectrum - optical spectroscopy - linear and nonlinear optical spectroscopy.

UNIT – III | **SYNTHESIS OF NANOSTRUCTURE MATERIALS:** | **Hours: 9**

Gas phase condensation – Vacuum deposition -Physical vapor deposition (PVD) - chemical vapor deposition (CVD) – laser ablation- Sol-Gel- Ball milling –Electro deposition- electroless deposition – spray pyrolysis – plasma based synthesis process (PSP) - hydrothermal synthesis

UNIT – IV | **CHARACTERIZATION:** | **Hours: 9**

Principle and working of Atomic Force Microscopy (AFM) and Scanning tunneling microscopy (STM) - near-field Scanning Optical Microscopy – Principle of Transmission Electron Microscopy (TEM) – applications to nanostructures – nanomechanical characterization – nanoindentation

UNIT – V | **NANOTECHNOLOGY APPLICATIONS:** | **Hours: 9**

Applications of nanoparticles, quantum dots, nanotubes and nanowires for nanodevice fabrication – Single electron transistors, coulomb blockade effects in ultra-small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs – CNT based transistors – principle of dip pen lithography

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text/ References:

1. "Nanotechnology" G. Timp. Editor, AIP press, Springer-Verlag, New York, 1999
2. "Nanostructured materials and nanotechnology'', Concise Edition, Editor:- Hari Singh Nalwa; Academic Press, USA (2002).
3. "Hand book of Nanostructured Materials and Technology'', Vol.1-5, Editor:- Hari Singh Nalwa; Academic Press, USA (2000).
4. "Hand book of Nanoscience, Engineering and Technology (The Electrical Engineering handbook series), Kluwer Publishers, 2002
5. "Sol-Gel Science", C.J. Brinker and G.W. Scherrer, Academic Press, Boston (1994).
6. Nanoscale characterization of surfaces & interfaces, N John Dinardo, Weinheim Cambridge: Wiley-VCH, 2nd ed., 2000.

Web sites: {optional}

Department : PHYSICS		**Programme : M.Sc (Materials Science & Technology)**							
Semester:		**Category : TY**							
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**			
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**	
PHY57	**LASER SPECTROSCOPY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**	

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Understand the concepts of laser
	CO2	Learn the laser spectroscopic methods
	CO3	Impart knowledge in new developments and laser spectroscopy
	CO4	Study the applications of laser spectroscopy
	CO5	Gain knowledge in nonlinear spectroscopy

UNIT – I	**Introduction to Laser**	**Hours: 9**
Laser as light source, fundamentals of laser- laser resonators, spectral characteristics of laser emission, single-Mode lasers, wavelength tuning of single-Mode lasers- line width. Nonlinear optics: Harmonic generation, second and third harmonic generation, frequency mixing ,-phase conjugation		
UNIT – II	**Laser Spectroscopy**	**Hours: 9**
Laser Raman spectroscopy – basic experimental techniques, non-linear Raman spectroscopy, special techniques, CARS – applications		
UNIT – III	**New developments and Laser Spectroscopy**	**Hours: 9**
New developments in laser spectroscopy – optical quenching – trapping of atoms – spectroscopy of single ion, optical Ramsey fingers, atom interferometry, one atom Maser, squeezing.		
UNIT –IV	**Applications of Laser Spectroscopy**	**Hours: 9**
Application of Laser Spectroscopy - Application in chemistry – environmental – biological – medical – technological applications.		
UNIT – V	**Nonlinear spectroscopy**	**Hours: 9**
Nonlinear spectroscopy – linear- nonlinear absorption, saturation of in homogeneous line profile, saturation spectroscopy, polarization spectroscopy, multiphoton spectroscopy – special techniques		

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text Books:

Laser Spectroscopy- Basic Concepts and Instrumentation, W. Demtroder, Springer, Third Edition, 2004. Chapters 5,7,8,11,14 and 15

Reference Books:

1. Laser Technology and Applications, S.L. Marshall, Mc. Graw Hill Book Co., 1980.
2. Laser in Industry, S.S. Charachan, Van Nostrand Reinhold Co., 1975.
3. Laser Electronics, by Joseph T. Verdeyen, PHI 1993.
4. Laser theory and applications, K. Thiagarajan and A. Ghatak, Me Millan, 1991.

Web sites: {optional}

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Department : PHYSICS										Programme : M.Sc (Materials Science & Technology)
Semester:										Category : TY

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
PHY58	MEASUREMENT AND INSTRUMENTATION	3	0	0	3	40	60	100

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Gain knowledge on physical measurements
	CO2	Learn the instrumentation system design
	CO3	Study the functions of bridges, recorders and transducers
	CO4	Study the instrumentation electronics
	CO5	Gain knowledge in advanced measurements

UNIT – I **Physical Measurements** **Hours: 9**

Measurement – result of a measurement – uncertainty and experimental error – systematic error – random error – repeated measurements – data distribution functions; mathematical description, derivation and properties – propagation error – analysis of data – multiparameter experiments

UNIT – II **Instrumentation System Design** **Hours: 9**

Experiment design – transducers – characteristics of transducers – selection of transducer – modeling external circuit components – instrument probes – power measurements – measurement methods – dc and ac bridge measurements – LCR bridges – Q meter – Megger.

UNIT – III **Bridges, Recorders And Transducers** **Hours: 9**

Wheatstone's bridge – Kelvin's bridge – double bridge – bridge controlled circuits – digital readout bridges – AC bridges – bridges for capacitance and inductance comparison – Wien bridge – resonance bridge – types of detectors – strip chart recorders – X-Y recorders – digital data recording – recorder specifications – applications – electrical, resistive transducers – strain gauges – RTD – thermistor – LVDT – pressure inductive transducers – capacitive transducer (pressure) – load cell (pressure cell) – piezo electric, photoelectric and photo-voltaic transducers – photo diode and photo transistor – temperature and frequency generating transducers – flow measurements

UNIT – IV **Instrumentation Electronics** **Hours: 9**

Op-amps – instrumentation amplifier – signal conditioning – filters - analog signal processing – high speed A/D conversion – D/A conversion – digital logic levels – digital instrumentation – frequency measurements – FFT – sampling time and analyzing – IEEE 488 interface bus – LabView (basics) – nuclear instrumentation.

UNIT – V **Advanced Measurements** **Hours: 9**

Spectroscopic instrumentation – visible and IR spectroscopy – spectrometer design – refraction and diffraction – lenses and refractive optics – dispersive elements – lasers – fiber optics – X-ray fluorescence: line spectra and fine structure – absorption and emission processes – X-ray production – X-ray diffraction and crystallography – neutron diffraction – TEM – SEM – atomic force and tunneling scanning microscope.

Total contact Hours: 45	Total Tutorials:	Total Practical Classes:	Total Hours: 45

Text/ Reference Books:

1. M. Sayer and A. Mansingh, "Measurement, instrumentation and experiment design in physics and engineering", Prentice-Hall India Pvt.Ltd., New Delhi, 2000.
2. H.S. Kalsi, 'Electronic instrumentation', (2nd Edition), Tata McGraw Hill Publ.Co.Ltd., New Delhi, 2004.
3. R.F. Coughlin and F.F. Driscoll, "Operational amplifiers and linear integrated circuits", Pearson Education, New Delhi, 2001.
4. E.O. Doebelin, "Measurement systems: Applications and design", McGraw-Hill, New York,

2002.Rangan Sharma and Mani, “Instrumentation devices and systems”, Tata McGraw-Hill, New Delhi, 2000.
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<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PHY59</td><td>NANOMATERIALS: PREPARATION and CHARACTERIZATION</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
</table>

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Understand the basic properties of nanoparticles
	CO2	Gain knowledge in nanotubes
	CO3	Study the various physical and chemical synthesis of nanowires and nanofibers
	CO4	Study the characterization nano materials
	CO5	Gain knowledge in nanodevices and its memory storage systems

UNIT – I	**Basic Properties of Nanoparticles**	**Hours: 9**

Size effect and properties of nanoparticles - particle size - particle shape - particle density - melting point, surface tension, wettability - specific surface area and pore size – Reason for change in optical properties, electrical properties, and mechanical properties - advantages

UNIT – II	**Nanotubes**	**Hours: 9**

Single walled and Multi walled Nanotubes (SWNT and MWNT) - synthesis and purification - synthesis of carbon nanotubes by pyrolysis techniques - arc-discharge method - nanotube properties – Nanowires – methods of preparation of nanowires –VLS mechanism

UNIT – III	1 **Nanowires And Nanofibers**	**Hours: 9**

Semiconductor and oxide nanowires –preparation –solvothermal – electrochemical –PVD –Pulse laser deposition – template method (qualitative)- nanofibers –electro spinning technique

UNIT – IV	**Characterization**	**Hours:9**

Nano SEM - Scanning Conducting microscopy (SCM) - near-field Scanning Optical Microscopy - High-resolution Transmission Electron Microscopy (HRTEM)- Absorption and emission spectra – PL spectrum - single nanoparticle characterization –Scanning capacitance microscopy – capillary electrophoresis-laser induced fluorescence (CE-LIF)

UNIT – V	**Nanodevices**	**Hours: 9**

Magnetic storage: magnetic quantum well; magnetic dots - magnetic date storage - high density quantized magnetic disks - magnetic super lattices – MRAMS - MTJs using nanoscale tunneling junctions – nanomaterial sensors

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text/ Reference Books:

1. "Nanoparticle Technology Handbook", Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, Elsevier Publishers (2007).
2. "Nanomaterials Synthesis, properties and applications", Editor:- A.S Edelstein, IOP Publishing, UK (1996).
3. "Nanostructured materials and nanotechnology'', Concise Edition, Editor:- Hari Singh Nalwa; Academic Press, USA (2002).
4. "Hand book of Nanostructured Materials and Technology'', Vol.1-5, Editor:- Hari Singh Nalwa; Academic Press, USA (2000).
5. "Carbon nanotubes: preparation and properties", Editor: - T.W. Ebbesen, CRC Press, USA (1997).
6. Zhon Ling Wang, Characterization of nanophase materials, ISBN: 3527298371, Wiley-VCH Verlag GmbH (2000)

Web sites: {optional}

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Department : PHYSICS		**Programme : M.Sc (Materials Science & Technology)**						
Semester:		**Category : TY**						
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
PHY60	**NANOSCALE FABRICATION and TECHNIQUES**	**3**	**0**	**0**	**3**	**40**	**60**	**100**
Prerequisite:	**-**							

	The course will enable the student to	
Course Objective	**CO1**	Impart knowledge on the scaling laws in 3D, 2D, 1D and 0D
	CO2	Impart knowledge on the various aspects of preparation techniques clean rooms to large scale integrations
	CO3	Study the different techniques of preparation
	CO4	Study the latest fabrication methods
	CO5	Gain knowledge application and analysis of MEMS and NEMS

UNIT – I | **Scaling laws in miniaturization** | **Hours: 9**

Heat conduction in micro- and nano- systems: heat conduction equation, Newton's cooling law, heat conduction in multilayered thin films, heat conduction in submicron scale - Quantum phenomena in nano-systems: photonic band gap structure, quantum states in nano-sized structures, quantum transport

UNIT – II | **Clean room** | **Hours: 9**

Need for a clean room – Types of clean rooms – maintenance of different types of clean rooms – oxidization and metallization- masking and patterning

UNIT – III | **Preparation techniques** | **Hours: 9**

Basic micro- and nano-fabrication techniques: thin film deposition, ion implantation, diffusion, oxidation - surface micromachining, LIGA process -Packaging: die preparation, surface bonding, wire bonding, sealing, assembly Measurement techniques : scanning tunneling microscope, atomic force microscope, focused ion beam technique- nanoindentation, nanotribometer

UNIT – IV | **Nano-fabrication: principles and techniques** | **Hours: 9**

Etching technologies - wet and dry etching - photolithography – Drawbacks of optical lithography for nanofabrication - electron beam lithography – ion beam lithography -dip-pen nanolithography, stamping techniques, strain-induced self-assembly for Nanofabrication of quantum dot and molecular architectures - Polymer processing for biomedical applications

UNIT – V | **Applications and devices** | **Hours: 9**

Mechanics for micro- and nano-systems: bending of membrane and cantilever, resonance vibration, fracture, stress, nano Tribology -Fluid dynamics for micro- and nano- systems: surface tension, viscosity, continuity equation -laminar fluid flow, fluid flow in submicron and nanoscale- Surface acoustic wave (SAW) devices, microwave MEMS, field emission display devices, nanodiodes, nanoswitches, molecular switches, nano-logic elements- Super hard nanocomposite coatings and applications in tooling- Biochemistry and medical applications: lab-on-a-chip systems

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text/ Reference Books

1. T.R. Hsu, MEMS & microsystems design and manufacture, Boston, McGraw Hill, 2002.
2. S.E. Lyshevski, Nano- and microelectromechanical systems, Boca Raton, CRC Press, 2001.
3. R. Waser (ed.), Nanoelectronics and information technology, Aachen, Wiley-VCH, 2003.
4. B. Bhushan, Springer handbook of nanotechnology, Berlin, Springer-Verlag, 2004.
5. J.A. Pelesko and D.H. Bernstein, Modeling MEMS and NEMS, Boca Raton, Chapman &Hall/CRC, 2003.

Web sites: {optional}

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Department : PHYSICS						Programme : M. Sc (Material Science & Technology)			
Semester:						Category : TY			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
PHY61	NON DESTRUCTIVE TESTING TECHNIQUES	3	0	0	3	40	60	100	

Prerequisite:	-	
	The course will enable the student to	
Course Objective	CO1	Understand the basics of Non Destructive Evaluation
	CO2	Highlight the need of Ultrasonic methods
	CO3	Impart knowledge in Radiographic methods
	CO4	Discuss the Acoustic methods and calibration
	CO5	Study the various surface analysis methods

UNIT – I | **Non Destructive Evaluation- Introduction** | **Hours: 9**

Principle, developments of methods, standards and limitations. Possible material defects in Casting, Forging and Welding Metallurgical process.

Visual observation and liquid penetrant techniques – Magnetic Particle and eddy current methods: Basic principles – limitations and applications.

UNIT – II | **Ultrasonic methods** | **Hours: 9**

Transducers – Ultrasonic beam profile – loss energy in transmission – probe heads – probe selection – angle beam probes – contact type probes – immersion probes – Twin element probe – focused transducers – testing techniques – pulse echo - contact, immersion through transmission – resonance methods – performance evaluation of NDT transducers – calibration blocks.

UNIT – III | **Radiography Techniques** | **Hours: 9**

X ray and gamma ray radiography: X-ray film processing-film types-Geometrical factors-Penetrameters-Weld radiography-pipe radiography-reference radiography-Image intensifiers. Gamma ray radiography: Half-life –curie-Roentgen-Half value layer thickness-Gamma ray sources-Permissible exposure-Exposure calculation.

Principles of Neutron Radiography – Sources – Slow neutron beams – Neutron image detectors – flaw detection by Neutron radiography – limitation of Neutron radiography – comparison with X-ray radiography.

UNIT – VI | **Acoustic wave methods** | **Hours: 9**

Electromagnetic Acoustic transducers – generation of various types of waves – Laser generated Ultrasonics - Thermo elastic generation of Ultrasonics – Ultrasonics in ablation regimes – Laser Ultrasonics at an angle calibration – Acoustic Emission flaw detection.

UNIT – V | **Surface Analysis methods** | **Hours: 9**

Methods using electron low energy electron diffraction (LEED)-reflection high energy electron diffraction (RHEED)-Neutron - diffraction technique: neutron spectrometer-neutron diffraction in hydrogeneous matter-detection of antiferroemagentism

Total contact Hours: 45	Total Tutorials: 0	Total Practical Classes: 0	Total Hours: 45

Text Books:

1. Ultrasonic Testing of Materials, J. Kraut Kramer and H. Kraut Kramer, Narosa Publishing House, New Delhi 1993.
2. Non Destructive Testing , Hull .B and John V.B., , Mc Millan ELBS, 1998.
3. Practical Non Destructive Testing, Beldevraj, Jayakumar and Thavasimuthu, Narosa Publishing House, New Delhi 2007.

Reference Books:

1. Non-Destructive Testing of Examination- Hand Book, Edr. Knud.G.Boving, Jaico Pub. House, New Delhi, 1995.
2. Neutron Radiography – a Monograph, IGCAR Kalpakkam, Sep. 1999.
3. Treatise on Materials Science and Technology, Vol. 27, “ Analytical technique for thin films”, Academic Press, Inc., New York, 1991.
4. Transducer for Ultrasonic Flaw Detection, V.N. Bindal, Narosa Publishing House, New Delhi 1999.
5. X-ray and Neutron diffraction, Bacon, GE, Pergamon Press, 1966.
6. Non Destructive Testing of welds, Beldevraj and Jayakumar, Narosa Publishing House, New Delhi 2000.

Web sites: {optional}

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3

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Semester:		**Category : TY**						
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
PHY62	**SEMICONDUCTOR DEVICE TECHNOLOGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Understand the unipolar devices
	CO2	Highlight the need unipolar devices
	CO3	Impart knowledge in photonic devices optoelectronics
	CO4	Understand the concepts transistor structures
	CO5	Study the different fabrication technology

UNIT – I | **Bipolar Devices** | **Hours: 9**

P-N junction under Zero bias condition – V-I characteristics - Depletion Capacitance - Diffusion capacitance - Tunneling and Tunnel diodes - Schottky barriers – Ohmic contacts – UJT: Principle and operation- V-I characteristics - Bipolar junction transistors (BJT): Principle of operation, doping profile – doping profiles –BJT as a amplifier - BJT as a switch.

UNIT – II | **Unipolar Devices** | **Hours: 9**

FET: Basic principle – General characteristics of JFET and MOSFET – charge – coupled Devices (CCD) – MOSFET – Principle and operation - Structures – Advanced in MOSFET's – effect of gate and Drain voltage on carrier mobility.

UNIT – III | **Photonic Devices / Optoelectronics** | **Hours: 9**

Introduction- Crystalline solar cells – solar radiation and ideal Conversion efficiency – PN-Junction solar cells – hetero junction, interface and thin film solar cells- amorphous silicon solar cells –LEDs – Semiconductor lasers – Photo detectors –Photo diode- PIN photo diode.

UNIT – IV | **Transistor structures** | **Hours: 9**

Electron transport in short devices and compound semiconductor technology – Permeable Base Transistors – Planar doped barrier devices – Real space transfer and hot electron injection transistors– Super lattice devices – Resonant tunneling devices.

UNIT – V | **Fabrication Technology** | **Hours: 9**

Purity of silicon- Wafer Preparation, Etching, Photolithography-Epitaxial growth-ohmic contacts-Fabrication of resistors and capacitors ICs– Thin film technology.

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text Books:

1. Physics of Semiconductor Devices – Michael Shur, Prentice Hall India 1995.
2. Physics of Semiconductor Devices – S.M.Sze, 2nd Ed Wiley – interscience ltd (2004).
3. Semiconductor Devices; An Introduction – Jasprit Singh, Mc.Graw Hill, (1994).

Reference Books:

1. Semiconductor Physics and Devices – Basic principles – Donald A. Neamen 3rd Ed. Tata Mc graw Hill (2005).
2. Semiconductor Devices, Kanaan Kano, - pearson Education, Inc. (2004).
3. Physics of Technology of Semiconductor Devices – Andrew S.Grower.

Web sites: {optional}

1

Department : PHYSICS			Programme : M.Sc (Materials Science & Technology)						
Semester:			Category : TY						
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
PHY63	SENSOR TECHNOLOGY		3	0	0	3	40	60	100
Prerequisite:	-								
	The course will enable the student to								
Course Objective	CO1	Impart knowledge in different types of measurements							
	CO2	Highlight the need sensors and gauges							
	CO3	Study the methods for temperature measurement							
	CO4	Gain the knowledge about types of sensors							
	CO5	Study the different non linear materials as sensors							

UNIT – I	**Types of Measurements**	**Hours: 9**
Load cell – pressure transducers – Bourdow tubes – diaphram elements – Bell gauge – Electrical types, Mechanical types – Low pressure measurements – mechanical, electrical and thermal types – ionization gauges – differential pressure transducers.		
UNIT – II	**Sensors and Gauges**	**Hours: 9**
Sensors for displacement – velocity – acceleration and torque – electrical transducers for displacement – strain gauges – capacitance gauges – LVDT – Piezo electric transducers – measurement of quantities.		
UNIT – III	**Temperature Measurement**	**Hours: 9**
Temperature Measurement: Solid and fluid expansion type – resistance thermometers – thermo emf – thermisters – radiation pyrometers – thermography – measurement of very high or Stellar temperature.		
UNIT – IV	**Types of Sensors**	**Hours: 9**
Flow and level measurements: Head types – Installation procedure – pitet tubes – area and mass flow meters – Positive displacement flow meters – electrical turbo magnetic and electromagnetic flow meters. Hot wire anemometers – open channel flow. Float type level measurement – displacement type – hydrostatic types – thermal effect type – electrical methods and magnetic methods.		
UNIT – V	**Non Linear materials as Sensors**	**Hours: 9**
Materials for Transducers: Barium Titanate KDP, ADP, PDVE films, TaS, thermal sensors of ABO_3 type, Wurtzite etc.		

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text/Reference Books:

1. Principles Industrial Instrumentation, D. Patranaris, Tata McGraw Hill, New Delhi, 1991.
2. Measurement Instrumentation and Experiment design in Physics and Engineering, M. Sayer and Abhai Mansingh, Printice Hall Pvt. Ltd, 2000.
3. Instrumentation and Devices, C.S. Rangan, G. Sharma and Mani , Tata McGraw Hill, New Delhi, 1985.
4. Physical Properties of Materials, Lovell, et al, ELBS, 1984.

Web sites: {optional}

1

<table>
<tr><td colspan="2">Department : PHYSICS</td><td colspan="7">Programme : M.Sc (Materials Science & Technology)</td></tr>
<tr><td colspan="2">Semester:</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>PHY64</td><td>SOLID STATE IONICS</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
</table>

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Impart knowledge in basic aspects of solid state physics
	CO2	Study the solid state ionics and its applications
	CO3	Study the micro batteries and application
	CO4	Understand the characterization of new battery materials
	CO5	Learn the applications of ionic materials

UNIT – I | **Basic Aspects Of Solid State Physics** | **Hours: 9**

Review-Types of bonding in solids-Fundamentals of Crystallography-Simple Crystal structures, X-ray diffraction-band structures of metals, semiconductors and insulators-Ionic and electronic conductivities.

UNIT – II | **Solid State Ionics** | **Hours: 9**

Concept of solid state ionics- Importance of super-ionic materials and structures-Classification of Super ionic solids- Experimental probes pertaining to solid state ionics- Theoretical models of fast ion transport- Applications of fast ionic solids-Hydrogen storage materials- Nano-ionic materials.

UNIT – III | **Micro Batteries And Application** | **Hours: 9**

Concept of a thin film solid state battery- electrolyte thin films- flash evaporation technique-pulsed laser deposition technique-applications-electromotive force-reversible cells-free energy changes-capacity of a cell-power and energy density of a cell-polymer electrolytes-application of polymer electrolytes in micro batteries, Fuel cells-solid state battery-super capacitors.

UNIT – IV | **Characterization Of New Battery Materials** | **Hours: 9**

Phase identification- Thermal analysis-DTA-DSC-TG- Energy dispersive X-ray fluorescence spectroscopy (EDX)-Atomic absorption (AAS)-Rutherford Back scattering spectroscopy-X-ray photoelectron spectroscopy-Structural characterization-XRD-Electron microscopy, local environment studies-Extended X-ray absorption fine structure-FTIR-Transport measurements-Electrical transport-transient transport.

UNIT – V | **Applications Of Ionic Materials** | **Hours: 9**

Primary lithium batteries-lithium sulphur dioxide, Li-Vanadium Pentoxide, Secondary lithium batteries-Li-ion electrode materials-preparation and fabrication- -characterization of Li-ion cells-Comparison of Li-iodine and NiCd cells in CMOS-RAM applications. Applications of Lithium batteries in electronic devices, electric vehicle, fuel cells, sensors -Solar energy conversion devices.

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes:0**	**Total Hours: 45**

Text/Reference Books:

1. H.V.Keer, Principles of solid state physics, Wiley Eastern Ltd, New Delhi, (1993).
2. S.Chandra, Superionic solids-Principles and applications, North Holland Amsterdam (1981)
3. D.S.Clive, Modern Battery Technology, Alean International Ltd, Banbury, Elis Horwood Publishers,(1991)
4. T.R.Crompton, battery reference book, Reed Educational and Professional publishingLtd, SAE International (1996)
5. Ozin, Geoffrey.A, Arsenault, Andre C, Nanochemistry, A chemical approach to Nanomaterials, Springer (2005)

Web sites: {optional}

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Department : PHYSICS	Programme : M.Sc (Materials Science & Technology)
Semester:	Category : TY

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
PHY65	STRUCTURE and PROPERTIES OF ALLOYS	3	0	0	3	40	60	100

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Impart basics of solid solutions
	CO2	Study the phase diagram of eutectic alloys
	CO3	Study the cast and wrought alloys and its properties
	CO4	Understand the two phase alloys
	CO5	Learn the different structures iron-carbon alloys

UNIT – I	**Solid Solutions**	**Hours: 9**

Concept of solid solution-solid solutions of Copper and Iron - Cu-Ni phase diagram - cast cupro nickel microstructures -properties of annealed copper solid solution alloys -soft magnetic alloys-stainless steels.

UNIT – II	**Eutectic Alloys**	**Hours: 9**

Pb-Sb phase diagram and microstructure - Pb-Sn phase diagram - Cu:O system - ternary Pb-Sn-Sb phase diagram - characteristic properties of eutectic system alloys -applications of Pb-Sn and Pb-Sn-Sb alloys.

UNIT – III	**Cast and Wrought Alloys**	**Hours: 9**

Al-Si phase diagram - Al-Cu phase diagram -coherency theory of age hardening - microstructures cast aluminium alloy -properties-residual stresses and relaxation.

UNIT – IV	**Two Phase Alloys**	**Hours: 9**

Cu-Zn phase diagram – Cu-Zn alloy structure - Cu-Sn and Cu-Al alloy systems and their microstructures -properties of brasses, tin brasses and aluminium bronzes.

UNIT – V	**Iron-Carbon Alloys**	**Hours: 9**

Fe-Fe_3C phase diagram - solubility of carbon in austenite and ferrite-terminology-equilibrium and non equilibrium - microstructures-properties of normalised steels - grain size of steels-engineering applications of low carbon steels and low alloy high strength steels

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text/ Reference Books:

1. Structure and Properties of Alloys, R.M.Brick and Arthur Philips, MCGraw Hill ., inc, NY, 1985.
2. Solid State Physics - Structure and properties of materials, M.A.Wahab, Narosa publishing house, New Delhi, 1999.
3. Heat Treatment - Principle and Techniques, T.V.Rajan, C.P.Sharma and Ashok Sharma, Prentice Hall of India pvt. Ltd., New Delhi, 1995.
4. Materials Science and Processes, M.K.Muralidhara, Dhanpat Rai publishing co. , New Delhi, 1998.
5. Charlie Brooks, R,Heat Treatment, Structure and properties of non ferrous alloys, American Society for Metals, U.S.A, 1984.

Web sites: {optional}

Department : PHYSICS			**Programme : M.Sc (Materials Science & Technology)**						
Semester:			**Category : Ty**						
Course Code	**Course Name**		**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
PHY66	**THERMODYNAMICS**		**3**	**0**	**0**	**3**	**40**	**60**	**100**
Prerequisite:	**-**								
	The course will enable the student to								
Course Objective	**CO1**	Convey the basics of thermodynamics							
	CO2	Establish the importance of laws of thermodynamics							
	CO3	Study the entropy related problems							
	CO4	Understand the thermal system							
	CO5	Learn the specific heat capacity and its relations							
UNIT – I	**Introduction to Thermodynamics**					**Hours: 9**			
System control volume, process cycles, homogeneous – heterogeneous system, quasi static process – continuum concept, zeroth law of thermodynamics – concept of temperature- pressure-volume diagram- pv = c, pv^{n} = c, pv$^{\gamma}$ =c, ideal gas, temperature work and heat transfer, path and point function, work done in free expansion – zero work transfer, work transfer-heat transfer as a path function.									
UNIT – II	**First and Second Law of Thermodynamics**					**Hours: 9**			
First law of thermodynamics – system undergoing change of state, energy a property- specific heat at constant volume and constant pressure –PMMI, Second law of thermodynamics- cycle, difference between heat and work, efficiency of heat engine, Kelvin Planck, Clausius statement - refrigerator-heat pump- COP, equality of Kelvin Plank and Clausius statement, reversibility, irreversibility -causes, Carnot’s cycle- Carnot’s theorem, equality of thermodynamic scale and Kelvin scale of temperature.									
UNIT – III	**Entropy**					**Hours: 9**			
Entropy- Clausius theorem, entropy as a property, T-S diagram, Clausius inequality, change in entropy in irreversible process, entropy principle –application, maximum work obtainable, change in entropy with heat flow, change in entropy of closed system-open system, directional law of nature, entropy and disorder, available energy, quality of energy, maximum work done in reversible process with heat exchange, dead state.									
UNIT – IV	**Thermal System**					**Hours: 9**			
Pure substance- gases and mixtures, P-V diagram of water and other substances, P-T diagram, PVT diagram, TS diagram, HS diagram (Mollier chart) dryness fraction, steam tables, saturation state-liquid vapour mixture, super heated liquid, Compressed liquid, thermodynamic properties chart, equation of state, ideal gas – specific heat at constant pressure, internal energy, enthalpy and entropy change of ideal gas, reversible adiabatic-isothermal process, change in entropy in poly tropic process, virial expansion, law of corresponding states.									
UNIT – V	**Specific Heat Capacity**					**Hours: 9**			
Mixture of gases-Daltons law of partial pressure, internal energy, enthalpy, specific heats at constant pressure and volume change in entropy of mixtures, Gibb’s function, Maxwell’s equations, TdS equation, $C_p – C_v$, C_p/C_v, energy equation, Joule Kelvin effect, Clausius Clapeyron equation, mixture of variable composition, equilibrium conditions of heterogeneous system, Gibbs phase rule-types equilibria, stability condition.									
Total contact Hours: 45		**Total Tutorials: 0**	**Total Practical Classes: 0**				**Total Hours: 45**		
Text Books:									
1. P.K. Nag, Engg. Thermodynamics Tata .Mc. Graw Hill 1995.									
Reference Books:									

1. Zemansky M.W., Heat and Thermodynamics, Mc. Graw Hill 1957.
2. Evelin Guha, Heat and Thermodonamics T.Mc. Graw Hill, 1998.
3. Arora C.P. Heat and Thermodynamics, Tata Mc. Graw Hill, 1998.
4. Huang F.F. Engg. Thermodynamics, Mac Millan, 1989.
5. Adrian Bejan, Advance Engg. Thermodynamics, John Wiley, 1988.

Web sites: {optional}

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Department : CHEMISTRY					Programme : M.Sc Material Science				
Semester:					Category : TY				
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
CYY51	CERAMIC MATERIALS	3	0	0	3	40	60	100	
Prerequisite:	-								
	The course will enable the student to								
Course Objective	CO1	Convey the basics of ceramics							
	CO2	Study the types of ceramics materials							
	CO3	Study the processing of ceramics							
	CO4	Impart the knowledge in equilibrium diagrams in ceramic							
	CO5	Learn the different properties of ceramic materials							

UNIT – I	Introduction to Ceramics	Hours: 9

Nature of Ceramic materials-crystalline ceramic materials-Silicates and clay minerals and spinal structures-Polymorphic transformations-glass and non-crystalline phases-structure and Composition of glass-Surface and interface.

UNIT – II	Types of Ceramics materials	Hours: 9

Ceramic raw materials-clay materials-silicate and silicate minerals-synthetic raw materials-oxide(like AL_2O_3,ZrO_2, TiO_2,MgO) and non –oxide (like Si_3N_4,AlN,BN,SiC) raw materials. Synthetic techniques-sol-gel processing, liquid-phase reaction and hydrothermal synthesis.

UNIT – III	Processing of Ceramics	Hours: 9

Processing of Ceramics-powder pressing, slip casting, firing-thermal treatment procedure-drying, sintering, and annealing-viscosity based transition points in glass-glass forming methods, glass ceramics.

UNIT – IV	Equilibrium Diagrams in Ceramic	Hours: 9

An outline of ceramic equilibrium diagrams-One component SiO_2, two component (Al_2O_3, Cr_2O_3, MgO-CaO,MgO-Al_2O3,Al2O_3-SiO_2,Al_2O_3-BeO) and qualitative ideas of methods of representation of three component diagrams-Nucleation-grain growth.

UNIT – V	Properties of Ceramic Materials	Hours: 9

Mechanical properties of ceramic materials-elastic properties and strength-Griffith's theory-plastic and viscous deformations-strengthening of glass.
Thermal properties-thermal expansion, heat capacity and thermal conductivity-thermal stresses.
Electrical and magnetic properties of ceramic materials-ceramic insulators and capacitors, Ferro electric ceramics, varistors, spinal ferrites and garnets

Total contact Hours: 45	Total Tutorials: 0	Total Practical Classes: 0	Total Hours: 45

Text Books:

1. L.H Van Vlack-Physical ceramics for Engineers-Addison Wesley,1964
2. F.H Norton-Elements of ceramics- Addison Wesley,1974

Reference Books:

1.W.D Kingery, H.K Bowen, D.R Uhlmann-Introduction to ceramics-2nd edition, John Wiley & Sons,1991
2. D.Ganguli and M.Chatterjee-Ceramic powder preparation:A hand book-Kluwer Academic Publishers,1997
3. David Segal-Chemical Synthesis of advanced Ceramic Materials-Cambridge University Press-1989
4.A.R West, Solid State Chemistry and its Application- John wiley & sons,1984
5.James S Reed, Principles of Ceramic Processing, John wiley & Sons INC, NY,1995

Web sites: {optional}

1

Department : CHEMISTRY						Programme : M.Sc Material Science			
Semester:		**Category : TY**							
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**			
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**	
CYY52	**POLYMERS AND COMPOSITE MATERIALS**	**3**	**0**	**0**	**3**	**40**	**60**	**100**	
Prerequisite:	-								
	The course will enable the student to								
Course Objective	**CO1**	Understand the fundamental concepts of polymers and composites							
	CO2	Study the various fabrication methods							
	CO3	Study the testing of polymers and composites							
	CO4	Learn the properties of polymers and composites							
	CO5	Gain the application of polymers and composites							
UNIT – I	**Fundamental concepts of Polymers and Composites:**				**Hours: 9**				
Introduction - classification of Polymers and Composites –Types of Polymerization and Mechanisms-Molecular weight of Polymers-Number average and weight average concepts-Degree of Crystallinity and Glass transition temperature of Polymers-Relationship between Tg and Tm									
UNIT – II	**Fabrication:**				**Hours: 9**				
Compounding of plastics-injection, compression moulding - Preg moulding - Blow Moulding – calendaring and lamination techniques of plastics-Fabrication methods of composites-powder metallurgy, hot pressing, hot rolling, co-extrusions, fiber reinforced metals									
UNIT – III	**Testing of Polymers and Composites**:				**Hours: 9**				
Testing of polymers-Chemical identification methods-tensile and bending strength-impart resistance-fatigue-dielectric strength-testing of composites-stress distribution and load transfer-prediction of strength of impurities-anisotropy-failure criteria									
UNIT – IV	**Properties of polymers and composites:**				**Hours: 9**				
Preparation and properties of polymers-strength-plastic deformation-mechanical, optical and electrical properties with reference to important engineering plastics-LDPE, HDPE, PVC, Polyester, phenol formaldehyde, alkyds, cellulose, silicones, epoxy resin and elastomers-properties of composites-micro mechanics, inter phase band.									
UNIT – V	**Application of polymers and composites:**				**Hours: 9**				
Application of polymers and plastic fibers-elastomers-coating adhesives-bio medical application-fiber reinforced plastic-conducting polymers and fire retarding polymers. Applications of Composites: Aircraft engineering-space hardware-wind turbine-marine craft-space structure-applications in biomedical field.									
Total contact Hours: 45	**Total Tutorials:**	**Total Practical Classes:**				**Total Hours: 45**			
Text Books:									
1 Text book of Polymer Science, Fred. W.Billmeyer, Jn.Wiley Interscience,1994. 2 Introduction to Polymer science ,A.R Gowarikar.etal, Tata Mcgraw Hill Book co.,India. 3 The Science and Engineering of Materials, Donald R.Askeland,PWS-KENT Publishing company,Boston,1980. 4 An Introduction to Composite Materials, Derek Hull, Cambridge University press,1988.									

Reference Books:
1 Composite Materials: Engineering and Science,Mathews,F.L.,Chapman&Hall,1994. 2 Composite Materials Hand Book,M.M.Schwartz,Mcgraw Hill Book Co.,1984. 3 Joel R.Fried,Polymer Science and Technology, Prentice-Hall, New Jersey,1995.
Web sites: {optional}
1 2 3

Department : Mechanical Engineering	**Programme : M.Sc (Materials Science & Technology)**
Semester:	**Category : TY**

Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
MEY96	**METALLURGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Prerequisite:	-	
	The course will enable the student to	
Course Objective	**CO1**	Impart knowledge in defects in solids
	CO2	Impart knowledge on the rules governing the formation of solid solutions
	CO3	Understand the concepts of phase diagrams
	CO4	Learn the different heat treatment process
	CO5	Gain knowledge about solid deformations

UNIT – I	**Defects in Solids**	**Hours: 9**

Defects in solids: Imperfections in solids – Point defects – vacancies – Frenkel and Schottky defects – dislocations – geometry of edge and screw dislocations – Burger vector – energy of a dislocation – stress to move a dislocation – critical resolution shear stress – slip systems in crystalline solids – dislocation multiplication stacking faults and twins.

UNIT – II	**Classification of Alloys**	**Hours: 9**

Classification of alloys – Hume-Rothery rules – dendrites – constitutional super cooling – segregation and zone refining – formation of solid solutions – intermediate phases

UNIT – III	**Phase Diagrams**	**Hours: 9**

Phase diagrams: Free energy composition curves – Lever rule – Eutectic, peritectic and peritectoid systems – Solid state reactions –important of equilibrium diagrams – Effect of alloying elements on the Fe- C diagram- Fe-C system – Copper alloys – Magnesium alloys – Experimental determining of equilibrium diagrams – Non-equilibrium structure – TTT diagram – Hyper eutectoid steels.

UNIT – IV	**Heat Treatment Process**	**Hours: 9**

Annealing, Normalising, Hardening, Spheroidising, Martempering and Austempering. Hardness and hardenability. Hardenability test Casehardening processes – Carburising, cyaniding and carbonitriding, nitriding, Flame hardening and induction hardening.

UNIT – V	**Solid Deformations**	**Hours: 9**

Categories of phase – diffusion in solids – nucleation and growth kinetics-bainitic transformations- martensitic transformations-– Recovery, recrystallization and grain growth – plastic deformation mechanisms – fracture – fatigue failures -Powder metallurgy and sintering metallic glasses

Total contact Hours: 45	**Total Tutorials: 0**	**Total Practical Classes: 0**	**Total Hours: 45**

Text Books:

1. Van vlack, Elements of Materials Science, Addison & Wesley, 1964.
2. Raghavan, Physical Metallurgy – Principles and Practice, Prentice Hall India, 1993.
3. Raghavan, Materials Science and Engineering, PHI Private Limited, New Delhi, 2003.

Reference Books:

1. A.C. Guy and Hren, Elements of Physical Metallurgy, Oxford University Press, 1974
2. S.Clark and R.Varnery, Physical Metallurgy, Affiliated East Press, 1962
3. R.E.Reedhill, Physical Metallurgy Principles, Affiliated East West Press, New Delhi,1973
4. John Wulff et al., The structure & properties of Materials, Vol.II, John Wiley, 1964.
5. Irving Granet, Modern Materials Science, Reston Publishing Co., 1980
6. S.H.Avner, Physical Metallurgy, McGraw Hill, 197
7. Donald R.Askeland, PradeepP.Fulay, D.K.Bhattacharya ,Materials science and Engineering , cengage learing publishing -2010

Web sites: {optional}
1

Department : Mechanical Engineering				Programme : M.Sc (Materials Science & Technology)						
Semester:				Category : TY						
Course Code	Course Name			Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	SE	TM
MEY97	CORROSION SCIENCE and ENGINEERING			3	0	0	3	40	60	100
Prerequisite:	-									
	The course will enable the student to									
Course Objective	CO1	Understand the concepts of corrosion								
	CO2	Learn the different types of corrosion								
	CO3	Understand the concepts intergranular corrosion								
	CO4	Study the kinetic aspects of corrosion								
	CO5	Impart the knowledge of corrosion in inhibition								
UNIT – I	Introduction to Corrosion						Hours: 9			
Importance of corrosion prevention in various industries: The direct and indirect effects of corrosion – The free energy and oxidation potential – the pilling Bed work ratio and it consequences – corrosion rate expressions – The importance of pitting factor – Pourbaix diagrams of Fe – Their and limitations										
UNIT – II	Types of Corrosion						Hours: 9			
Localized corrosion: The electro chemical mechanism Vs. The chemical mechanism – Galvanic corrosion – prediction using emf Series and Galvanic series – Crevice corrosion – Mechanism of differential oxygenation corrosion – Auto catalytic mechanism of pitting due to crevice or differential oxygenation corrosion – Principles and procedures of cathodic protection: Sacrificial anodes and external cathodic current impression – stray current corrosion										
UNIT – III	Intergranular corrosion						Hours: 9			
Intergranular corrosion: Stainless steels – cause and mechanism (Cr- Depletion theory) – Weld decay and knife line attack – Stress corrosion and fatigue corrosion – Theory of critical corrosion rate in corrosion fatigue. Uniform corrosion - Pitting corrosion - erosion corrosion- Fretting damage – Cavitation damage-hydrogen damage. High temperature Oxidation of metals – Ionic diffusion through protective oxides – Classification on the basis of kinetics or rates of oxidation.										
UNIT – IV	Kinetic aspects of corrosion						Hours: 9			
Kinetic aspects of corrosion: Exchange current density - activation polarization and concentration polarization– combined polarization -Mixed potential theory – Phenomenon of passivation – Theories – effect of oxidizing agents and velocity of flow on passivating metals – Tafel extrapolation – linear polarization										
UNIT – V	Corrosion in inhibition						Hours: 9			
Corrosion in inhibition: Inhibiters of corrosion – passivators, adsorbing inhibiters, V.P. inhibiters. Bacterial corrosion – Marine corrosion – Control methods. Control of Bacterial corrosion -Corrosion prevention by Coatings – Surface pre- treatment – Hot dip, diffusion and cladded coatings – Phosphating and its uses. thermal spray coating –high velocity oxyfuel coating (HVOF) –thermal barrier coating.										
Total contact Hours: 45		Total Tutorials: 0		Total Practical Classes: 0				Total Hours: 45		

Text Books:
1. Uhlig H.H, “Corrosion and its control”, Willey, 1985. 2. Fontanna, “Corrosion Engineering”, (Materials Science and Metallurgy series), third edition, McGraw Hill inter national Ed., 1987 3. Kenneth R. Trethewey and John Chamber lain, “Corrosion for Students of Science and Engineering”, Long Mann Scientific and Technical edition, 1988.
Reference Books:
. Pludek, “Design and corrosion prevention”, McMillan, 1978. 2. Raj Narain, “Introduction to metal corrosion”, Oxford IBH, 1983 3. A.S. Khanna “Introduction to high temperature oxidation and corrosion” , ASM International , 2002
Web sites: {optional}
1