OUR MISSION

To provide value-based technical education and mould the character of the younger generation through a synthesis of science and spirituality so that their earnest endeavour to achieve progress and prosperity in life is matched by an ardent desire to extend selfless service to the society, one complementing the other.

Dr. K. Sankaran
Registrar
Amrita Vishwa Vidyapeetham
Amrita Nagar, COIMBATORE - 641

AMRITA
VISHWA VIDYAPEETHAM
(U N I V E R S I T Y)

Established under Section 3 of the UGC Act 1956
Coimbatore - 641 105.

Integrated Master of Science
(Mathematics/Physics)

Regulations, Curricula and Syllabi

(for the students admitted from the year 2009 onwards)

AMRITA SCHOOLS OF ARTS AND SCIENCES

AMRITAPURI - KOCHI - MYSURU

Chairman - University Post-graduate Programme Committee

Dr N S Pandian

Chairman - Arts and Sciences Programme Committee
Dr C S Shastry

BOARD OF STUDIES FOR INTEGRATED M SC (MATHS/PHYSICS) PROGRAMME 2009 - 2012

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8. **Dr. T.R. Ramakrishnan,**
   (Rtd. Prof., National Institute of Technology, Calicut), Kochi - EXTERNAL EXPERT
9. **Dr. K. Neelakandan,**
   (Rtd. Prof., Univ. of Calicut), Kochi - EXTERNAL EXPERT

AMRITA VISHWA VIDYAPEETHAM

AMRITA SCHOOLS OF ARTS AND SCIENCES

REGULATIONS FOR THE

Integrated M Sc (Mathematics/Physics) DEGREE PROGRAMME

- **General**

Dr.K. Sankarna
Registrar
Amrita Vishwa Vidyapeetham
Amrita Nagar, COIMBATORE - 641 112

GENERAL

1. Candidates who have passed the final examination under the 10 +2 system or its equivalent with a minimum of 50% of marks in aggregate and with Mathematics and Physics as subjects, are eligible to apply for admission to the Integrated M Sc degree programme. However, the eligibility criterion is subject to modification, as per the directives of competent authorities.

2. Procedure for admission will be decided from time to time by the University in accordance with the guidelines from competent authorities.

3. The duration of the Programme will normally be ten semesters, spread over five academic years.

4. The award of the Integrated M Sc degree will be recommended by the Academic Council and approved by the Board of Management in accordance with the regulations of the University.

5. Notwithstanding anything stated above, the Amrita Vishwa Vidyapeetham reserves the right to modify any of the ordinances, as deemed fit, from time to time.

R.1 Admissions

R.1.1 The admission to the programme will be as per the ordinances and regulations of the University.

R.1.2 The intake to each school will be decided by the University from time to time.

R.1.3 Transfer of students from one campus to another is generally not permitted. However, based on the availability of vacancy in the discipline and the academic merit of the student, special cases may be allowed in the beginning of the third semester, on the mutual consent of the Heads of both the Departments and Schools and with the approval of the University. The decision of the University will be final in this matter.

R.2 Language of Instruction

The language of instruction will ordinarily be English, for all courses.

R.3 Structure of the Programme

R.3.1 The Programme will be structured on credit based system and continuous evaluation, following semester pattern.

R.3.2 The programme consists of the following.
(a) Core courses in the primary area of the programme, including seminars, projects, etc.
(b) Allied courses
(c) Elective courses
(d) Humanities and General Studies (like *Environmental Sciences, Languages* and *Cultural Education*, etc.)

Additionally, soft skill training and some social interaction/social work, which may be part of *Cultural Education* may also be insisted upon.

R.3.3 The curriculum of the Integrated M Sc degree programme will have credits, apportioned in the following knowledge segments:
Core subjects (incl. Electives)
Allied subjects (incl. Electives)
Humanities and General Studies

R.3.4 Credits are assigned to the courses based on the following general pattern
One credit for each lecture period per week
One credit for each tutorial period per week
One credit for each laboratory course/practical of two/three periods per week

R.3.5 The Integrated M Sc degree programme shall have a curriculum, as prescribed.

R.3.6 The curriculum and the syllabi may be updated from time to time by the Academic Council.

R.3.7 Core, allied, elective: Certain courses in each knowledge segment are identified as Core courses, certain others as allied courses and few others as electives.

There is mandatory registration and credit earnings requirement for core courses. While it is mandatory to register for the allied courses, failure to earn credit in them does not necessarily mean repeating the

courses. Often another course may be permitted as replacement course. Electives are free to be chosen from those offered.

R.4 Tuition Fees

At the beginning of each academic year, students shall pay all the fees prescribed. A student who drops out of the programme or whose registration is cancelled due to any reason, cannot claim refund of any fees paid.

R.5 Faculty Advisor

In order to (i) guide the students in planning their courses of study (ii) advise them on academic programmes and (iii) monitor their progress, the departments will assign a certain number of students to a faculty member, who will be designated as their Faculty Advisor.

R.6 Course Committee

The programme in all the campuses will be governed by the same curricula and syllabi. Course committees are constituted for running each course in all the campuses at the same time and shall be common for all the campuses. The committee for each course shall comprise of mentors from each campus offering the program.

The course committee shall interact at the beginning of the semester to finalize teaching programme as well as evaluation pattern, and during the middle of the semester to finalise the Question papers and keys for the end-semester examination.

The mentor in each campus will coordinate all aspects of teaching of the course in the respective campus, by convening meetings of all teachers handling the course.

R.7 Class Committee

R.7.1 Each "semester" class of students of the programme will have a class committee, in each School, in a campus. Thus, there will be a class committee for, say, the first semester Integrated M Sc, another for the third semester Integrated M Sc, etc.

R.7.2 The Class Committee shall be constituted by the Chairperson of the department.
The constitution of the class committee will be as follows:
a) The convener of the class committee who is a faculty member who

may not be handling any course for the class concerned, nominated by chairperson of the department,
b) All the teachers handling courses for the class,
c) The faculty advisor of the class,
d) Two student representatives nominated by the Chairperson of the department.
The chairperson of the department may attend the committee meetings as a special invitee.

R.7.3 The class committee shall meet at least thrice in a semester. The student representatives will attend only those class committee meetings, for which they are invited.

R.7.4 The class committee shall meet at the beginning of the semester to finalise the academic programme as well as evaluation pattern. At the end of the semester the committee (without student representatives) will meet to finalise the results.

R.8 Pre-registration and Registration

R.8.1 Every student shall register for the courses which he/she wishes to undergo during a semester.

R.8.2 Except for the first semester, pre-registration for a semester will be done during a specified week before the end semester examination of the previous semester. The consent of the faculty advisor is mandatory before pre-registering for every course. Additionally the consent of the teacher is also necessary.

R.8.3 From the second semester onwards, all students have to register at the beginning of a semester. Registration will be open for the first two days of the semester. A student will be eligible to register only if he/she satisfies the condition R.13. (given later in this document) and will be permitted to register only if he/she has cleared all the dues to the Institution, hostel, library etc., at the time of registration and if he is not debarred from registration as part of any disciplinary action of the Institution.

R.8.4 At the time of registration, a student can drop a course registered earlier or substitute a course by another for valid reasons, with the consent of the faculty advisor.

R.8.5 Late registration will be permitted on payment of a specified late fee upto a period of five working days from the last date specified for registration.

R.8.6 The maximum number of credits that can be registered for by a student in a semester is limited to 28.

R.8.7* Students having F grade in any subject(s) in the previous semester(s) will not be permitted to register for more than 24 credits in the current semester.
*(*deleted, with effect from the even semester of the academic year 2010-11, upto the ninth semester of the programme only)*

R.9 Dropping Courses
The curriculum for any semester except for the final semester will have normally around 24 credits. If a student finds his/her load heavy in any semester, or for any other valid reasons, he/she may drop courses without any academic penalty within three weeks of the commencement of the semester, but before commencement of the first periodical test, with the written approval of his/her faculty advisor and Chairperson of the Department. However, the student should ensure that the credits registered in any semester should enable him/her to earn the minimum number of credits specified in R.13.

Withdrawal from one or more courses after the specified date will entail academic penalties in the form of a 'Failed, due to lack of attendance', "FA" grade appearing on the grade card.

R.10 Vacation Courses
Vacation courses may be offered by a department with the approval of the Principal concerned, according to requirements and as per rules framed for the purpose.

R.11 Re-appearance Examinations (Re-evaluation of courses)
Students who have failed to earn credits for a course even after two registrations, can register for re-evaluation of the course, on payment of a prescribed fee. Re-evaluation is a provision for the student to earn credits for the course, by appearing for the examinations (without attending classes) in that course, whenever held. Re-evaluation can be done either for both internal assessment and end semester examinations or only for the end-semester examinations.

Effective from 2010 admissions:
Students securing an 'F' grade, in a theory-based course and earning 40% of marks or more, in the Internal Assessment component of evaluation, shall be eligible to re-appear directly for the end-semester examination, in that course, whenever held. This shall be applicable only upto the sixth semester of the programme.

R.12 Contact Courses
A contact course may be offered during the regular semester or summer term by a department, as per rules to a final year student who has obtained 'F' grade in one or two course(s). The course(s) will be offered only on the recommendation of the department which offered the course(s) and with the approval of the Principal concerned.

R.13 Eligibility to continue the Programme

R.13.1 A student has to earn a minimum of 10 credits in the first semester to continue in the second semester. However under special circumstances a student who fails to earn 10 credits in the first semester may be allowed to continue in the second semester with a severe warning, as per the rules framed for the purpose.

R.13.2 At the end of the second semester the student should have earned 22 credits cumulatively (including vacation course, if any) to continue in the third semester.

R.13.3 From the beginning of the fourth semester onwards, a student must have earned the minimum number of cumulative credits, as mentioned below, to be eligible to move to the higher semester –
At the beginning of the minimum credits to have been earned, cumulatively

IV semester	35 credits
V semester	50 credits
VI semester	67 credits
VII semester	90 credits
VIII semester	110 credits
IX semester	132 credits
X semester	156 credits

Eligibility to continue (effective from 2010 admissions):
At the beginning of second to sixth semester, a student shall have not more than five arrear courses (excluding Lab. courses, Courses in Cultural Education and Soft Skills). Those who have more than

five arrear courses, at the beginning of the semester (till the sixth semester), shall register for all the available arrear courses of earlier semesters and then register , if possible, for courses of the higher semester, subject to a maximum of 28 credits.

However, from the seventh semester onwards, a student shall have not more than three arrear courses (excluding Lab. courses and Courses in Cultural Education). Those who have more than three arrear courses, at the beginning of the VII, VIII, IX or X semesters, shall register for all the available arrear courses of earlier semesters and then register, if possible, for courses of the higher semester, subject to a maximum of 28 credits.

R.14 Maximum Duration of the Programme

R.14.1 A student is expected to complete the programme in sixteen semesters. However, a student may complete the Integrated M Sc degree programme at a slow pace within sixteen semesters, with the prior permission of his/her Faculty Advisor and Chairperson of the Department, but he/she has to satisfy the condition stipulated in R.13.

R.14.2 A student may be permitted by the Principal concerned to withdraw from the programme for a semester or a longer period for reasons of ill health or on other valid grounds. In such cases the maximum duration of the programme will be extended and ratified by the Academic Council.

R.14.3 EXIT OPTION

R.14.3.1 Candidates who desire to exit the programme at the end of the sixth semester, may do so on specific request to the concerned Head of the Institution.

R.14.3.2 Such students shall undertake a 8-credit (10-credit for 2010 batch onwards) Project, during the summer term, in the third year of their programme.

R.14.3.3 These students shall need to complete all the credit requirements prescribed upto the end of VI semesters, within a maximum period of ten semesters.

R.14.3.4 Such students shall be eligible for the award of the B Sc (Mathematics/Physics – dual major) degree and shall be eligible for classification, but not eligible for any ranking.

R.15 Attendance

R.15.1 Attendance of the students will be marked by the teacher during every period of a course.

R.15.2 Every student, registered for a course, is expected to attend 100% of the classes conducted for the course. A minimum attendance of 80% of all the classes engaged is essential before the student is permitted to write the end semester examination of the concerned course(s).

R.15.3 Leave of absence on genuine grounds can be permitted up to a maximum of 20%, provided the leave is applied for in time, and sanctioned (either in advance, or immediately after the period of absence, according to the merits of the case). Unauthorized absence will be treated as breach of discipline.

In the case of illness, leave must be applied for, supported by a proper medical certificate and recommended by the Medical Officer attached to the School.

If the student is away to represent the University in sports, games, technical seminar, etc., he/she can be considered to be "on other duty". "Duty leave" for these days can be granted and generally for not more than five days in a semester.

R.15.4 Finalization of attendance for every course shall be done few working days before the last instruction day of the semester. Any student failing to secure a minimum of 80% attendance in a course will not be eligible to appear for the end semester examination in that course.

If the attendance of a student falls short of 80% in any course, due to continuous absence caused by accident, prolonged illness, or unforeseen circumstances, such case may be considered by the Principal concerned for condonation of absence based on the request of the student supported by recommendation of the class advisor and chairperson of the department concerned.

R.15.5 In the case a student who is not permitted to attend the end semester examination in any course due to lack of attendance he/she will be awarded FA grade in that course, indicating 'failure due to insufficient attendance' and mentioned in the grade card.

R.16 Assessment Procedure

R.16.1 The academic performance of each student in each course will be assessed on the basis of continuous assessment and an end semester examination.

R.16.2 In theory courses (that are taught primarily in the lecture mode), the weightage for the continuous assessment and end semester examination will be 60:40. The continuous assessment in theory courses shall consist of at least two periodical tests, other quizzes, assignments, tutorials, viva voce etc., The weightage for these components will be decided by the course committee at the beginning of the semester. There will be one end semester examination of three hours duration in each lecture-based subject.

Effective from 2010 admissions -
The weightage for the Internal Assessment components, for theory-based courses, shall be 20 marks each, for the two periodical tests and 20 marks for the continuous assessment component, comprising of quizzes, assignments, tutorials, viva-voce, etc.

R.16.3 In the case of laboratory courses and practicals, the weightages for continuous assessment and end semester examination will be 80:20. The weightage for the components of continuous assessment will be decided by the course committee at the beginning of the course.

R.16.4 It is mandatory that the students shall appear for the end-semester examination for completion of the course.

R.16.5 If a student does not appear for any of the tests, he is not eligible to appear for the end semester examination and has to re-register for the course when offered next.

R.16.6 It is mandatory for the students to appear for the end-semester examination/Second-chance examination for completion of the course.

R.16.7 The continuous assessment of project work will be carried out as decided by the course committee. At the completion of the project work, the student will submit a bound volume of the project report in the prescribed format. The project work will be evaluated by a team of duly appointed examiners.

R.16.8 The final evaluation will be based on the content of the report,

presentation by student and a viva-voce examination on the project. There will be 40% weightage for continuous assessment and the remaining 60% for final evaluation.

R.16.9 If the project work is not satisfactory he/she will be asked to continue the project work and appear for assessment later.

R.17 Second-chance Examination (Supplementary Examinations)

R.17.1 A student who happens to be absent in the end semester examination will be awarded 'I' grade in the course (indicating incomplete). Those having I grade will be required with prior permission to appear for the second-chance examination for the examination. Second-chance examination will be conducted within a fortnight after publishing the results, as per the rules framed for the purpose.

R.17.2 The permission to appear for the second-chance examination will be granted under valid reason by the Principal concerned, on recommendation by the chairperson of the Department.

R.17.3 A student who secured 'F' grade will also be allowed to appear for second-chance examination as per the rules.

R.18 Grading

R.18.1 Based on the performance in each course, a student is awarded at the end of the semester a letter grade in each of the courses registered. The letter grades, the corresponding grade points and the ratings are as follows:

Letter Grade	Grade Points	Ratings
A+	10.00	Exceptional
A	10.00	Outstanding
A-	9.00	Excellent
B+	8.00	Very Good
B	7.50	Good
B-	7.00	Fair
C+	6.50	Above Average
C	6.00	Average
C-	5.50	Adequate
D	5.00	Marginal
F	0.00	Failed
FA	0.00	Failure due to lack of attendance
I	0.00	Incomplete
W		Withheld

Grade 'FA' grade once awarded stays in the record of the student and is not deleted even after he/she completes the course successfully later.

The grade 'I' will be subsequently changed into appropriate grade when the student takes the Second-chance examination or during the subsequent semester. If he/she does not complete it in the next semester, it will be converted into 'F' grade.

R.18.1.AThe Grading Pattern to be adopted for the students admitted to the programme from 2010 onwards, shall be as follows:

Letter Grade	Grade Points	Ratings
A+	10.00	Exceptional
A	10.00	Outstanding
B+	9.00	Very Good
B	8.00	Good
C+	7.00	Above Average
C	6.00	Average
D	5.00	Pass
F	0.00	Failed
FA	0.00	Failure due to lack of attendance
I	0.00	Incomplete
W		Withheld

R.18.2 Letter grades will be awarded by the Class Committee in its final sitting without the student representatives.

R.18.3 A student is considered to have successfully completed the course and earned the credit if he/she scores a letter grade 'D' or better in that course.

R.19 Declaration of Result

R.19.1 After finalization of the grades the result will be announced by the Principal concerned.

R.19.2 Classification of successful candidates:

Candidates who have successfully completed the programme, be classified as follows:

Candidates securing a CGPA of 8.00 and above –

FIRST CLASS WITH DISTINCTION

Candidates securing a CGPA between 6.50 and 7.99 – FIRST CLASS

Candidates securing a CGPA of 6.49 and less – PASS

and the same be mentioned in the Degree certificate";

R.20 Re-check/revaluation of answer Papers.

When the semester results are published, in case any student feels aggrieved, he/she can request for re-check/revaluation of answer scripts of the end semester examination. For this purpose, the student has to submit a request in the prescribed form to the Controller of Examinations/Principal within five working days from the publication of results along with the prescribed fees. When the re-check/ revaluation is completed, the results will be published. If the re-check/revaluation leads to a better grade, the revised grade will be awarded to the student and in such cases, the revaluation fee will be refunded in full.

Re-check/Revaluation will be allowed only for lecture based courses.

R.21 Course Repetition

R.21.1 A student who earned an 'F' or an 'FA' grade in a core course has to repeat the course compulsorily when the course is offered later.

R.21.2 A student who earned an 'F' or 'FA' grade in an elective course may repeat it or register for an alternate elective.

R.22 Semester Grade Point Average (SGPA)

On completion of a semester, each student is assigned Semester Grade Point Average (SGPA) which is computed as below for all courses registered by the student during that semester.

$$\text{Semester Grade Point Average} = \Sigma (C_i \times Gp_i) / \Sigma C_i$$

where C_i is the credit for i^{th} course in that semester and Gp_i is the grade point for that course.

The summation is over all the courses registered by the student during the semester including the failed courses. The SGPA is rounded off to two decimals.

R.23 Cumulative Grade Point Average (CGPA)

The overall performance of a student at any stage of the Degree programme is evaluated by the Cumulative Grade Point Average

(CGPA) upto that point of time.

$$\text{Cumulative Grade Point Average} = \Sigma (C_i \times Gp_i) / \Sigma C_i$$

where C_i is the credit for i^{th} course in any semester and Gp_i is the grade point for that course.

The summation is over all the courses registered by the student during all the semesters upto that point of time including the failed courses. The CGPA is also rounded off to two decimals.

The ranking of the students in a batch at any intermediate or final stage is based on CGPA.

R.24 Grade Card

The Grade Card issued to the student at the end of a semester will contain the following information

a) Code number, title and credits for each of the courses registered,
b) Letter grade secured, corresponding grade points,
c) Total number of credits earned by the student up during the semester,
d) SGPA of the semester and
e) CGPA upto and including the semester.

R.25 Transcript

The Controller of Examinations will also issue, on demand, a detailed transcript with his signature or facsimile to every student after completion of the programme. It shall contain all the information that is contained in the grade card. Additionally, it shall also include the month and year of passing each course. The transcript card shall contain only the final grades secured, but will not indicate the earlier failures, if any. The detailed transcript, will contain the CGPA and the class, if any obtained. It will not, however, indicate the disciplinary actions taken against the student.

R.26 Discipline

Every student is required and expected to observe strict discipline and decorous behaviour both inside and outside the campus. He/ she should not indulge in any activity which may tarnish the fair name and prestige of Amrita Vishwa Vidyapeetham. Any act of indiscipline or misbehaviour including unfair practice in the examinations will be dealt with by the Disciplinary Action committee of the institute constituted by the Principal concerned. The committee will enquire into the charges. Based on the findings of the committee,

Principal will take appropriate disciplinary action. Serious act of indiscipline on the part of the students may even attract penalty upto the extent of expulsion from the University

R.27 Redress of grievances

Students have the right to seek redress of grievances. For this, they have to appeal in writing to the Principal/Dean concerned who will take necessary steps in the matter.

R.28 Award of the Degree

A student will be declared eligible for the award of Degree of Integrated M Sc, if he/she has:

a) registered and successfully completed all the courses and projects;
b) earned the required minimum number of credits as specified in the curriculum, within the stipulated time;
c) earned the specified number of credits in all the categories of courses;
d) no disciplinary action pending against him/her; and
e) no outstanding dues against him/her.

The degree will be awarded by the Board of Management of Amrita Vishwa Vidyapeetham on recommendation of the Academic Council.

R.29 Interpretation Clause

Related to any of the academic matters, whenever there arises any doubt or dispute on the interpretation of regulations or rules, the decision of the Academic Council will be final as well as binding on all concerned.

R.30 Amendment to Regulations

Notwithstanding anything stated above, the Amrita Vishwa Vidyapeetham reserves the right to modify any of the regulations, as deemed fit, from time to time.

CURRICULUM

SEMESTER I

CourseCode	Course Title	L-T-P	Cr
ENG101	Functional English	1 1 0	2
	(Communicative English - 2010 onwards)	2 0 2	3
CHY200	Chemistry I	3 0 0	3
CSA136	Introduction to Programming using C	3 0 0	3
MAT101	Mathematical Foundations	3 1 0	4
PHY110	Mechanics	3 1 0	4
CSA186	Introduction to Programming using C Lab	0 0 3	1
PHY180	Physics Lab I	0 0 3	1
CUL101	Cultural Education I	1 0 0	1
	(from 2010 onwards)	2 0 0	2
			Total 19 (21 – 2010 onwards)

SEMESTER II

CourseCode	Course Title	L-T-P	Cr
ENG102	Professional Communication	1 0 2	2
CHY201	Chemistry II	3 0 0	3
CSA137	Programming using C	3 0 3	4
MAT102	Integration and Elementary Number Theory	3 1 0	4
PHY120	Electricity and Magnetism	3 1 0	4
PHY181	Physics Lab II	0 0 3	1
CUL102	Cultural Education II	1 0 0	1
	(from 2010 onwards)	2 0 0	2
			Total 19 (20 – 2010 onwards)

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SEMESTER III

CourseCode	Course Title	L-T-P	Cr
CHY202	Chemistry III	3 0 0	3
MAT201	Introductory Analysis and Algebra	3 1 0	4
MAT202	Vectors and Ordinary Differential Equations	3 1 0	4
PHY206	History and Philosophy of Science	2 0 0	2
PHY210	Heat and Thermodynamics	3 1 0	4
PHY220	Basic Electronics	3 1 0	4
CHY380	Chemistry Lab I	0 0 3	1
PHY280	Basic Electronics Lab	0 0 3	1
		Total	23

SEMESTER IV

CourseCode	Course Title	L-T-P	Cr
ENV101	Environmental Studies	3 1 0	4
LSG112	Introduction to Life Sciences	4 0 0	4
MAT203	Transforms and Partial Differential Equations	3 1 0	4
MAT211	Multivariate Calculus	3 1 0	4
PHY221	Wave Motion and Optics	3 1 0	4
PHY281	Physics Lab III	0 0 3	1
		Total	21

SEMESTER V

CourseCode	Course Title	L-T-P	Cr
BUS108	Principles of Management	2 0 0	2
MAT331	Linear Algebra and Discrete Mathematics	3 1 0	4
PHY321	Introduction to Electrodynamics	3 1 0	4
PHY340	Relativity and Modern Physics	3 1 0	4
STA200	Probability and Statistics	3 1 0	4
CHY381	Chemistry Lab II	0 0 3	1
MPJ397	Seminar	0 0 2	1
		Total	20

SEMESTER VI

CourseCode	Course Title	L-T-P	Cr
MAT310	Introductory Real Analysis	3 1 0	4
MAT311	Complex Analysis	3 1 0	4
PHY341	Solid State Physics and Devices	3 1 0	4
PHY342	Atomic, Molecular and Nuclear Physics	3 1 0	4
	Elective (Mathematics/Physics)	3 0 0	3
MPJ398	Seminar	0 0 2	1
	Total 20 *(28 for Exit Option students)*		
MPJ399	Project *(for students exercising Exit Option)*		8
	(2010 batch onwards)		10

Total credits at the end of VI semester - 122 (125 – 2010 onwards)
(130 for Exit Option students - 2009 batch and
135 for Exit Option students - 2010 batch onwards)

VI SEMESTER ELECTIVES

MAT322	Introduction to Discrete Mathematics
MAT332	Introduction to Operations Research
PHY252	Physics of Semiconductor Devices
PHY260	Physics of Lasers and Applications
PHY262	Introduction to Nonlinear Dynamics
PHY343	Mathematical Aspects of Mechanics

SEMESTER VII

CourseCode	Course Title	L-T-P	Cr
MAT411	Advanced Complex Analysis	4 0 0	4
PHY410	Classical Mechanics	4 0 0	4
PHY430	Quantum Mechanics I	4 0 0	4
PHY432	Mathematical Physics	3 0 0	3
MPJ480	Simulation Lab	0 0 3	1
PHY481	Physics Lab A	0 0 3	1
MPJ497	Seminar	0 0 2	1
		Total	18

Integrated M Sc (Mathematics Stream)

SEMESTER VIII

CourseCode	Course Title	L-T-P	Cr
MAT413	Theory of Ordinary Differential Equations	4 0 0	4
MAT414	Topology	4 0 0	4
MAT420	Linear Algebra	4 0 0	4
MAT430	Discrete Mathematics	3 0 0	3
MAT310	Real Analysis II	4 0 0	4
		Total	19

SEMESTER IX

CourseCode	Course Title	L-T-P	Cr
MAT500	Differential Geometry	3 0 0	3
MAT511	Measure and Integration	4 0 0	4
MAT513	Theory of Partial Differential Equations	4 0 0	4
MAT320	Advanced Algebra	4 0 0	4
	Mathematics Elective I	3 0 0	3
		Total	18

SEMESTER X

CourseCode	Course Title	L-T-P	Cr
MAT512	Functional Analysis	4 0 0	4
	Mathematics Elective II	3 0 0	3
	Mathematics Elective III	3 0 0	3
MAT399	Project		10
		Total	20

Integrated M Sc (Physics Stream)

SEMESTER VIII

CourseCode	Course Title	L-T-P	Cr
PHY400	Experimental Techniques	4 0 0	4
PHY420	Advanced Electrodynamics	4 0 0	4
PHY431	Quantum Mechanics II	4 0 0	4
PHY433	Advanced Mathematical Physics	4 0 0	4
PHY482	Physics Lab B	0 0 3	1
PHY498	Seminar	0 0 2	1
PHY499	Mini Project		1
		Total	19

SEMESTER IX

CourseCode	Course Title	L-T-P	Cr
PHY510	Statistical Mechanics	4 0 0	4
PHY520	Advanced Electronics	4 0 0	4
PHY540	Nuclear and Particle Physics	4 0 0	4
PHY541	Condensed Matter Physics I	3 0 0	3
PHY581	Electronics Lab	0 0 3	1
PHY582	Seminar	0 0 2	1
PHY596	Mini Project	-	1
		Total	18

SEMESTER X

CourseCode	Course Title	L-T-P	Cr
PHY542	Condensed Matter Physics II	3 0 0	3
	Physics Elective I	3 0 0	3
	Physics Elective II	3 0 0	3
PHY599	Project		11
		Total	20

Total Credits for the

5-year Integrated M Sc programme = 197 (2009 – 2010 onwards)

PHYSICS ELECTIVES

PHY450	Fundamentals of Plasma Physics
PHY451	Space Physics
PHY452	Nonlinear Dynamics
PHY453	Optoelectronics
PHY454	Introduction to Nanophysics and Applications

MATHEMATICS ELECTIVES

MAT422	Algebraic Number Theory
MAT431	Calculus of Variations
MAT501	Analytic Number Theory
MAT514	Operator Theory
MAT515	Integral Equations
MAT521	Algebraic Topology
MAT530	Continuum Mechanics
MAT531	Advanced Operations Research
MAT540	Combinatorics
MAT541	Advanced Graph Theory
MAT542	Automata Theory
STA430	Probability Theory
STA431	Stochastic Processes
STA432	Statistical Inferences

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SYLLABUS

BUS198	PRINCIPLES OF MANAGEMENT	2 0 0 2

Introduction to management, definition, nature and importance, role and skills of a manager, Planning, nature and purpose of planning, objectives of planning, steps in planning, Strategic policy, goal setting, decision making, SWOT analysis, organization structure, Departmentalization, line staff authority principles of staffing, Performance appraisal, career strategy, Leading, managing human factor, leadership, communication, controlling the system and the process, Introduction to management functional areas - Marketing, HR, Production and specialization, finance, Management Information System - managerial functional areas.

TEXTBOOK:

Harold & Heinz Weihrich,Principles of management, Tata McGraw Hill, 2007

REFERENCE:

TN. Chhabra, Principles of Management, Sri Dhanpath Rai & Co. Pvt Ltd

CHY200	CHEMISTRY I	3 0 0 3

Structure of the Atom and Chemical Bonding: Shape of atomic orbitals, nodal planes, degeneracy of atomic orbitals and behaviour of orbitals in external magnetic and electric fields, L - S coupling, j - j coupling, Schrodinger's wave equation – derivation, eigen values and eigen functions, normalization and orthogonality of wave function, operators in wave mechanics, postulates of quantum mechanics, applications of wave mechanics – electron in a ring and particle in a one-dimensional box, probability distribution curves for orbitals.

Molecular orbital theory – postulates and application to heteronuclear diatomic species such as HCl, NO, CO and NO^+. Metallic bond, theories of metallic bond – free electron theory, valence bond approach and band theory (conductors, insulators and semiconductors) – their successes and limitations.

Chemistry of Elements: Metallurgy, properties (physical and chemical), important compounds and alloys and uses of elements such as titanium, zirconium, tungsten, lanthanides, thorium, uranium and plutonium.

Nuclear Chemistry: Size of the nucleus, nuclear forces – Yukawa theory, structure of the nucleus – shell model and liquid drop model, stability of the nucleus – N/p ratio, packing fraction, mass defect and binding energy, radioactivity – alpha and beta particles and gamma radiation and their properties, detection and measurement of radioactivity – Geiger-Muller Counter and Wilson Cloud Chamber, isotopes,

isobars, isotones, isodiaspheres and nuclear isomers, separation of isotopes – diffusion, thermal diffusion, fractional distillation and evaporation and electrolysis, determination of nuclear masses – Thomson's method, Dempster's Mass Spectrograph and Aston's Mass Spectrograph.

The Kinetic Theory of Gases: Kinetic molecular theory of gases – postulates, kinetic gas equation – derivation, explanation of Boyle's law, Charles' law, Avogadro's law, Graham's law of diffusion and Dalton's law of partial pressure based on Kinetic theory (kinetic gas equation), kinetic energy of gases in terms of universal gas constant and Boltzmann constant, molecular velocities – most probable, average, mean square and root mean square velocities – expressions from Maxwell's equation for calculating these velocities (derivations not expected), molecular collisions in a gas – collision diameter, collision cross-section, collision number, collision frequency and mean free path – their calculations, specific heat capacity at constant volume (c_v) and at constant pressure (c_p), molar heat capacity at constant volume (C_v) and at constant pressure (C_p), relation between C_p and C_v, ratio of C_p and C_v for monoatomic, diatomic and triatomic gases.

Behaviour of Real Gases: Limitation of ideal gas equation, compressibility factor, Boyle temperature, deviation from ideal behaviour – explanation, van der Waals' equation of state for real gases – derivation and its different forms at different pressures and temperatures, Boyle temperature from van der Waal's constant, significance of van der Waal's constants, critical phenomena and their determination, P-V isotherms of CO_2, calculation of critical phenomena from van der Waal's constants.
(Note – Problems are compulsory)

TEXTBOOKS:

1. 'Advanced Inorganic Chemistry' by Gurdeep Raj. GOEL Publishing House (a unit of KRISHNA Prakashan Media (P) Ltd) 11, Shivaji Road, Meerut, U.P., Pin – 250001.
2. 'Principles of Physical Chemistry' by B.R.Puri, L.R.Sharma and Madan S.Pathania. Shoban Lal Nagin Chand & Co 6, U.B.Bungalow Road, Delhi – 7.
3. 'Advanced Physical Chemistry' by Gurdeep Raj. GOEL Publishing House (a unit of KRISHNA Prakashan Media (P) Ltd). 11, Shivaji Road, Meerut, U.P.

REFERENCES:

1. 'Inorganic Chemistry' by James E. Huheey. Harper &Row International Publishers Singapore.
2. 'Concise Inorganic Chemistry' by J.D.Lee. Blackwell Science Ltd Oxford.
3. 'Physical Chemistry' by P.W.Atkins. W.H.Freeman & Co.
4. 'Elements of Physical Chemistry' by S.Glasstone and D.Lewis. The Macmillan Company of India Limited.

CHY201 CHEMISTRY II 3003

Thermodynamics: System – isolated, closed and open systems, surroundings, extensive and intensive properties, thermodynamic processes – isothermal, adiabatic, isobaric, isochoric, reversible and irreversible, state functions and path functions, work and heat, first law of thermodynamics, internal energy and internal energy change, enthalpy and enthalpy change, enthalpy of fusion and vaporization, thermodynamics definitions of C_p and C_v, work done in reversible isothermal expansion and compression of a gas, work done in irreversible expansion, relations between temperature, pressure, volume and C_p/C_v, Joule-Thomson effect, Joule-Thomson coefficient – ideal and real gases, Joule-Thomson coefficient and inversion temperature from van der Waals constants, liquefaction of gases – Linde's process and Claude's process for the liquefaction of air, production of low temperatures – adiabatic demagnetization of paramagnetic substance, limitations of first law of thermodynamics, spontaneous and non-spontaneous processes, second law of thermodynamics, Carnot cycle, efficiency of a heat engine, entropy and its calculation, entropy change in isothermal expansion, entropy change in phase transitions, entropy change of an ideal gas with change in P, V and T, Gibbs free energy and change in free energy, Gibbs-Helmholtz equation, Clapeyron-Clausius equation – derivation (differential and integrated forms) and applications, third law of thermodynamics, calculation of absolute entropy, limitations of third law of thermodynamics.

Electrochemistry: Electrolysis, Faraday's laws of electrolysis, Ohm's law, conductance, specific conductance, equivalent conductance, determination of conductance, conductivity cells, cell constant, variation of conductance with dilution – strong and weak electrolytes, Kohlrausch's law and its applications, applications of conductance measurements, Hittorf's theoretical device, transport number, determination of transport number – Hittorf's method and moving boundary method, conductometric titrations, ionization, theory of ionization – Ostwald's dilution law and Debye-Huckel theory.

Chemical Kinetics: Rates of reactions, molecularity, order – zero, first, second and third order reactions with examples (qualitative treatment), simple and complex reactions, law of mass action, rate law, rate constant, first order rate constant – derivation of the expression, graphical evaluation of first order rate constant, kinetics of first order consecutive reactions, parallel reactions and reversible reactions (quantitative treatment – derivations), kinetics of enzyme catalysed reaction – the Michaelis Menten equation (derivation), Arrhenius equation, graphical evaluation of activation energy.

Organic Chemistry: Addition to double bond – addition of halogens, addition of

halogen acids, addition of sulphuric acid, hydration, hydroboration, addition of hypohalous acid, addition of oxygen, alkylation, addition of nitrosyl halides, addition of ozone – mechanism and stereochemistry, peroxide effect, aromaticity – molecular orbital theory and Huckel's rule, addition and substitution reactions of aromatic ring – mechanisms, benzyne mechanism.

TEXTBOOKS:

1. *"Principles of Physical Chemistry" by B.R.Puri, L.R.Sharma and Madan S.Pathania. Shoban Lal Nagin Chand & Co. 6, U.B. Bungalow Road, Delhi – 7.*
2. *"Advanced Physical Chemistry" by Gurdeep Raj. GOEL Publishing House (a unit of KRISHNA Prakashan Media (P) Ltd) 11, Shivaji Road, Meerut, U.P.*
3. *"Organic Chemistry Vol. 1" by I.L.Finar. Pearson Education.*
4. *"Textbook of Organic Chemistry" by P.L.Soni. Sultan Chand and Sons 23, Darya Ganj, New Delhi – 110002.*

REFERENCES:

1. *"Physical Chemistry" by P.W.Atkins. ELBS.*
2. *"Chemical Kinetics" by Laidler. Pearson Education.*
3. *"Organic Chemistry Volume 1: The Fundamental Principles" by I.L.Finar. ELBS.*
4. *"Organic Chemistry" by Bruice. Pearson Education.*

CHY202	CHEMISTRY III	3 0 0 3

Instrumental methods of analysis: Spectrochemical Techniques – Electromagnetic spectrum and analytical techniques, theory, instrumentation and applications of microwave, IR, UV-visible, NMR and mass spectroscopy.

Separation Techniques – Chromatographic methods – theory, instrumentation and applications of gas chromatography and HPLC.

Surface chemistry: Absorption, adsorption, adsorbents, adsorbates, sorption and occlusion – explanations with examples, thermodynamics of adsorption, types of adsorption of the gases on solids – physisorption and chemisorption, types of physical adsorption curves – isotherm, isobar and isostere, quantitative treatment of different adsorption isotherms – Freundlich Adsorption Isotherm and Langmuir Adsorption Isotherm, adsorption from solution (qualitative treatment), applications of adsorption.

Differences between solutions, colloidal state and suspension, dispersed phase and dispersion medium, lyophilic and lyophobic colloids, electrical properties of colloids – electrophoresis, electro osmosis, streaming potential and sedimentation potential, electrical double layer, theories about the structure of electrical double layer – Helmholtz-Perrin theory, Gouy-Chapman theory and Stern's theory, zeta potential (quantitative treatment).

Polymer Chemistry: Monomers and polymers, condensation and addition polymerizations and co-polymerization, mechanism and kinetics of free radical addition polymerization, polymerization techniques – bulk, solution, suspension and emulsion polymerizations, molecular weight distribution, number average and weight average molecular weights, determination of molecular weights – viscosity, ultracentrifuge, light scattering and GPC methods (qualitative treatment), inorganic polymers – silicones and phosphazines, biodegradable polymers, synthesis, characteristics and applications of some industrial polymers – Nylon 6,10, Nylon 66, Nylon 6, rayon, UF and PF resins, epoxy resins and PTFE.

Industrial materials: Nanomaterials – introduction, methods of synthesis, characteristics and applications. Biofuels – introduction, biopetrol, biodiesel, transesterification method, significance of properties of biodiesel – flash point, acid value, viscosity and cloud point.

Conducting Polymers – introduction, intrinsically conducting polymers (conducting polymers having conjugation and doped conducting polymers – p-doping, n-doping, polaron, bipolaron), extrinsically conducting polymers (conductive element filled polymers and blended conducting polymers), applications of conducting polymers.

Liquid Crystals – introduction, different types of liquid crystals, properties, applications.

TEXTBOOKS:

1. *"Fundamentals of Molecular Spectroscopy" by Banwell and McCash. Tata McGraw-Hill Publishing Company Ltd, New Delhi.*
2. *"Organic Spectroscopy" by William Kemp. Macmillan.*
3. *"Instrumental methods of Analysis" by Willard, Merritt, Dean, Settle. CBS Publishers and Distributors, 485, Jain Bhawan, Bhola Nath Nagar, Shahdara, New Delhi.*
4. *"Advanced Physical Chemistry" by Gurdeep Raj. GOEL Publishing House (a unit of KRISHNA Prakashan Media (P) Ltd) 11, Shivaji Road, Meerut, U.P.*
5. *"Polymer Science" by V.R.Gowariker, N.V.Viswanathan and Jayadev Sreedhar. New Age International (P) Limited Publishers.*

REFERENCES:

1. *"Vogel's Textbook of Quantitative Chemical Analysis". Pearson Education.*
2. *"Principles of Instrumental Analysis" by Skoog, Holler and Nieman. Thomson Books/Cole.*
3. *"Physical Chemistry" by P.W.Atkins. ELBS.*
4. *"Text Book of Polymer Science" by Fred W. Billmeyer, JR. A Wiley-Interscience Publication John Wiley & Sons.*

CHY380	CHEMISTRY LAB I	0 0 3 1

1. Estimation of sodium hydroxide using A.R sodium carbonate
2. Estimation of oxalic acid
3. Estimation of ferrous ion using internal indicator
4. Estimation of iodine
5. Estimation of Zinc
6. Estimation of Total, Permanent and Temporary Hardness of Water
7. Acid hydrolysis of Ethyl Acetate - Kinetic Aspects
8. Potentiometric titration of Fe^{2+} against $Cr_2O_7^{2-}$
9. Conductance measurement
10. Acid base titration by conductometric titration

CHY381	CHEMISTRY LAB II	0 0 3 1

1. Determination of critical solution temperature of phenol-water system
2. Determination of partition co-efficient of iodine between carbon tetrachloride and water
3. Determination of transition temperature of sodium thiosulphate pentahydrate
4. Thin Layer chromatography
5. Determination of heat of neutralisation of hydrochloric acid and sodium hydroxide
6. Determination of normality by pH meter
7. Estimation of phenol
8. Determination of % of copper in brass
9. Polymer preparation
10. Potentiometric titration of Fe^{2+} against $Cr_2O_7^{2-}$

CSA136	INTRODUCTION TO PROGRAMMING USING C	3 0 0 3

Computer - History, Generations, classifications, applications, input output devices, hardware units, algorithms and flowchart. What is a program?

What is a programming language? Fundamentals of a Programming Language, Different Programming Techniques - Procedural Programming, Modular Programming, Object Oriented Programming.

A little introduction to C, Writing a Program, Getting started with compiler, Alphabets in C, Keywords in C, Rules of forming Words in C language, Data Variables, Data Types and Rules for naming and declaring data variables

Basic Data Types in C, Constants, Rules for forming Sentences in C, Comments in C, Enumerated Data Types, Type Definitions, Input/Output Instructions.

Operators, Decision Control Instructions: If, If-else, If-else-if, Nested if-else, Conditions, Loop Control Instructions: For Loop, While Loop, Do While, What are strings? String I/O, String Manipulation Functions, Storage Classes and Scoping: Automatic, Register, External, Static, Scope of a Variable.

Arrays: What is an array?: Array Declaration, Array Initialization, Accessing individual elements of an array, Two Dimensional Arrays, Accessing the elements of a two dimensional array, More than two dimensions ,Passing an array element to a function, Rules of using an array.

Functions: Why use Functions, Components of Function, Name of a function, Body of a function, Local variables of a function, Parameters or Arguments to a function, Return Values, Prototype of a function, Rules of using a function.

Structures: Declaring and Accessing Structure, variables Uses of Structures.

TEXTBOOKS:

1. *Let Us C –Yaswant Kanitkar*
2. *Computer Programming in C –V Rajaraman*

REFERENCES:

1. *Mastering C, K R Venugopal, S R Prasad*
2. *Computer Concepts and C programming, Anami*

CSA137	PROGRAMMING USING C	3 0 3 4

Functions
Types of functions - User defined functions - Structure of a function – Execution Process of a function - Category of Functions - Function Prototyping - Nesting of Functions - Sending arrays to functions – Recursion

Structures
Structure Definition - Structure Initialization - Nesting of Structure - Arrays and Structures - Structure to functions

Pointers
Accessing the address of a variable - Declaring and initializing a pointer - Accessing variable through its pointer - Pointer to Pointer - Pointers and functions - Dynamic memory allocation

Data Structures in C
Overview of Data Structures - Primary Forms - Linked List, Queue, Stack

File Management in C
File Operations - I/O Operations on files - General Formats for declaring and opening a File

The Pre Processor
Preprocessor Directives - Macro Substitution directives - Command Line Arguments - Bitwise Operators

CSA186	INTRODUCTION TO PROGRAMMING USING C LAB	0 0 3 1

Computer Lab based on CSA136

CUL101	CULTURAL EDUCATION I (for 2009 batch only)	1 0 0 1

1. Introduction to Indian culture, definition and dimensions of Indian culture - need for awareness of cultural heritage, link between culture and values
2. Introduction to amma's life and teachings
   Anecdotes from Amma's life and conversations with disciples, illustrating various cultural and spiritual values
3. Symbols of Indian culture
   Forms, meanings and significance of symbols-religious symbols - Swastika, Omkara, Lingam, Lotus, Tilak, Rudraksha, Shanka and Salagrama
4. Science and technology in Ancient India
   Highlights of India's contribution in the fields of mathematics, astronomy, metallurgy and medicine.
5. Education in ancient India
   Ancient Indian educational system, the schools in 18th century, comparison with English education (from Dharpal's beautiful tree)
6. Goals of life – Purusharthas - Dharma, Artha, Kama, Moksha
7. Introduction to Vedanta and Bhagvat gita- respect for nature in Indian culture, sacredness of the universe, rivers, mountains, vehanas and ahsis wikshs, koil kadu
8. General section
   The Sindhu Saraswathy civilization, bridge of Rama - Ramasetu, the lost city of Dwaraka, the myth of Aryan invasion theory
9. Saints and seers of India – Veda Vyasa, Vishwamitra, Buddha, Mahavira, Adi Sankaracharya, Sri Ramanujacharya, Sri Madavacharya, Chaitanya Maheprabhu, Guru Nanak, Kabir etc, students projects on any of the saints and seers of India

REFERENCE BOOKS:

1. Eternally talented India-108 facts, Vivekananda life Skills academy publication
2. Mother of Sweet bites-MAM publication

NB: handout will be given to students occasionally, which will also serve for the purpose of a text book.

CUL101	CULTURAL EDUCATION I (for 2010 admissions onwards)	2 0 0 2

Introduction to Indian Culture
Introduction to Amma's life and Teachings
Symbols of Indian Culture
Science and Technology in Ancient India
Education in Ancient India
Goals of Life – Purushurthas
Introduction to Vedanta and Bhagavad Gita
Introduction to Yoga
Nature and Indian Culture
Values from Indian History
Life and work of Great Seers of India (1)

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TEXTBOOKS:

1. The Glory of India (in-house publication)
2. The Mother of Sweet Bites, (Amma's Life & Teachings)

CUL102	CULTURAL EDUCATION II (for 2009 batch only)	1 0 0 1

Bhagavad Gita and Life Management – Leadership, Teamwork, Motivation, Sense Management, Mind Management

Historicity of Ramayana and Mahabharata – Are Rama and Krishna historical characters? Is there evidence to prove the historicity of Ramayana and Mahabharata? Inspiring stories and characters from the epics.

Overview of Patanjali's Yoga Sutras with focus on value systems mentioned in Yama and Niyama.

Highlights of Indian Mythology – 18 Puranas, Vyasa, Inspiring Stories and Characters from the Puranas – Dhruva, Prahlada, Markandeya etc.

Indian Society: Its Strengths and Weaknesses – Discussion on strengths &

weaknesses of Indian society – family values, social values, community values etc., varnashrama, caste, dowry etc.

Role & Position of Women in Indian Society – Great women of India, rishikas in the vedas, women characters in the epics, decline of women's status.

Indian Models of Economy, Business and Management – how cultural values influence Indian economic processes, economic history of India.

Health and Lifestyle related issues – Drug Addiction, Stress Management, Mind-Body Relationship, psychosomatic disorders.

Conservation of cultural heritage – changing value systems in India – open debate on globalisation and its impact – role of youth in protecting and promoting Indian Culture & Heritage.

Life and work of Great Seers of India (2) – Nagarjuna, Padmasambhava, Swami Narayan, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Sri Aurobindo, Narayana Guru, Swami Chinmayananda, Peace Pilgrim, Dalai Lama, Antony De Mello and others – group presentations or project work to be done by students on the life and teachings of any one of the saints & seers.

TEXTBOOK:

Eternally Talented India – 108 Facts. Compilation published by Vivekananda Life Skills Academy, Hyderabad.

REFERENCE BOOKS (COMMON FOR BOTH SEMESTERS):

1. *Awaken Children Series (Vol 1-8), Mata Amritanandamayi Math*
2. *Dharampal – Collected Writings, Other India Press, Mumbai*
3. *Pride of India, Samskrita Bharati*
4. *Symbolism in Hinduism, Chinmaya Mission*
5. *Complete Works of Swami Vivekananda, Ramakrishna Math*
6. *Bhagavad Gita, Commentary by Swami Ranganathananda, 3 volumes, Sri Ramakrishna Math*
7. *Asana, Pranayama, Mudra and Bandha by Swami Satyananda Saraswati, Bihar School of Yoga*
8. *Meditation and Spiritual Life by Swami Yatiswarananda, Sri Ramakrishna Math*
9. *Great Women of India, Sri Ramakrishna Institute of Culture, Kolkata*
10. *Saints & Mystics of India, Sri Ramakrishna Math*
11. *Learn to Live (2 vols), Swami Jagadatmananda, Sri Ramakrishna Math*
12. *The Art of Man Making, Swami Chinmayananda, Chinmaya Mission*
13. *India's Contributions to World Thought and Culture, Vivekananda Kendra Patrika*
14. *Talks on Vedic Culture and Tradition by Swamini Pramananda Saraswati*
15. *Ramayana & Mahabharata by C. Rajagopalachari, Bharatiya Vidya Bhavan*

CUL102 CULTURAL EDUCATION II 2 0 0 2
(for 2010 admissions onwards)

Bhagavad Gita and Life Management
Historicity of Ramayana and Mahabharata
Overview of Patanjali's Yoga Sutras
Highlights of Indian Mythology
Indian Society: its Strengths and Weaknesses
Role & Position of Women in Indian Society
Indian Models of Economy, Business and Management
Health and Lifestyle related issues
Conservation of cultural heritage
Life and work of Great Seers of India (2)

TEXTBOOKS:

1. *The Glory of India (In-house publication)*
2. *Sanatana Dharma (A compilation of Amma's teachings on Indian Culture)*

ENG101 FUNCTIONAL ENGLISH 1 1 0 2
(for 2009 batch only)

Successful managers not only demonstrate excellent communication skills, they also make effective choices as they adapt their communication to a variety of purposes and audiences. This introductory course is an opportunity to run through the fundamentals inherent in English language.

Course Objectives:

1. *Strengthen the foundation in English of the learners*
2. *Make learners capable of handling English usage to suit basic needs.*

Selections in prose and poetry - as an aid to teach the elements of grammar and to illustrate usage of the following language components:

1. Elements of Grammar
   Parts of Speech (including Linkers); Tenses; Concord (Sub/Verb/ Antecedent); Punctuation; Articles; Basic sentence structures (assertive/ interrogative/ imperative/ exclamatory); Phrases and Clauses; Synthesis and Transformation of Sentences
2. Paraphrasing and Summarizing
3. Guided Paragraph Writing (writing stories from given outline/ framework, expansion of proverbs and the like)
4. Letter writing (Formal/ Leave letters/ other Requisition Letters)
5. Reading Practice and comprehension
6. Short speeches (Practical/ Class room work); Narration of incidents / stories / anecdote; Extempore (pick and speak)

TEXTBOOK:

David Green, A Contemporary English Grammar: Structure and Composition, Macmillan Publications

REFERENCE TEXTS:

1. N Krishnaswamy, Modern English: A Book of Grammar, Usage and Composition, Macmillan Publications
2. F T Wood, A Remedial English Grammar for Foreign Students, Macmillan Publications
3. Raymond Murphy, Murphy's English Grammar, Cambridge University Press, 2004
4. V Syamala, Effective English Communication for You, Emerald Publishers, 2004

ENG101	COMMUNICATIVE ENGLISH (for 2019 batch onwards)	2 0 2 3

OBJECTIVES: to make the student familiar with English syntax - to help the student to obtain ability to communicate - to impart an aesthetic sense and enhance creativity

Module 1
Parts of Speech, Kinds of sentences (declarative, imperative, interrogative, exclamatory)
Analysis of patterns of sentences (SVOCA...) Types of sentences (simple, complex, compound); Transformation of sentences

Module 2
Verbs: Regular and Irregular, Tenses, Voice, Concord

Module 3 Composition
Letter Writing: personal (Letters of request, invitation, felicitation, gratitude, condolence...), Paragraph writing (personal topics) Essay writing, Reading Comprehension.

Module 4 Speaking
Narration of incidents/stories/anecdotes, Situational dialogues.

Module 5
Selected essays, Short Stories and Poems

REFERENCES:

1. Sreenivasan S. Functional Grammar and Communicative Skills, Century publishers, Kollam
2. Seely, John. Writing and Speaking. OUP, 1998
3. Narayana Swamy, V.R. Strengthen your Writing, Orient Longman
4. Syamala, V. Speak English in Four Easy Steps, Improve English Foundation Trivandrum, 2008
5. Martinet, Thomson, A Practical English Grammar IV Ed. OUP, 1986

ENG102	PROFESSIONAL COMMUNICATION	1 0 2 3

Module 1 Sentence: Transformation and Synthesis, Reported Speech, Error Analysis

Module 2 Paragraph (General Topics), Official Letters, Job Application, Resume, Instruction, Suggestion & Recommendation

Module 3 Reports, Circulars, Memos

Module 4 Mock Press, Interviews, Role play, Group Discussion, Situational Conversation

Module 5 Book Review

REFERENCES:

1. Felice Exley Tech Talk, University of Michigan, 2000
2. Michael Swan, Practical English Usage, Oxford University Press, 2005
3. Anderson, Paul. Technical Communication A Reader-Centered Approach, 7 Edition, Heinle, 2003.
4. Raymond V. Lesikar and Marie E. Flatley, Basic Business Communication, Tata McGraw Hill Pub. Co. New Delhi, 2005. Tenth Edition.

ENV101	ENVIRONMENTAL STUDIES	3 1 0 4

The Multidisciplinary nature of Environmental Studies, Definition, scope & importance, Need for public awareness, Natural Resources, Renewable and non-renewable resources, Natural Resources and associated problems, Role of individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles

Ecosystems, Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Ecological succession, Types of ecosystems

Biodiversity and its conservation, Species & ecosystems diversity, Biogeographical classification of India, Value of biodiversity, Biodiversity at global, national & local levels, India as mega-diversity nation, Hotspots of biodiversity, Threats to biodiversity, Endangered and endemic species of India, Conservation of biodiversity

Environmental Pollution, Definition, Causes, effects and control measures, Solid Waste Management, Role of the individual in the prevention of pollution, Pollution Case Studies, Disaster management

Social issues and the Environment, Unsustainable and sustainable development, Energy and the urban environment, Water conservation, Resettlement & rehabilitation of people, Environmental ethics, Global Warming & climate change, Environmental Protection Act, Wildlife protection, Forest conservation, Environmental legislation, Public Awareness

Human Population & the Environment, Population growth patterns, Population explosion, The environment & human health, The role of spirituality in fostering environmental harmony

Field Work, Visit to local area to document environmental assets, Visit to local polluted site/ environmental disaster site, Study of common plants, insects, birds, Study of local ecosystem.

TEXTBOOK:

Bharucha, E. (2000). Textbook of Environmental Studies. University Grants Commission, University Press

LSG112 INTRODUCTION TO LIFE SCIENCES 4 0 0 4

Introduction to biology – Life, space biology, basic life functions, energetic - thermodynamics and life, comparison between computers and life, basis of life, principles of biology, Astrobiology goals and objectives.

Cells and life – Eukaryotic cells, Mitosis overview, Components of cells, Prokaryotic cells, differences between eukaryotes and prokaryotes, cellular dynamics, features like oxygen transport, electrical activity, circadian rhythms.

Brain – Brain as a model biological system, basic physiology and functions, brain as a physical system (self organization, complex functions from simple parts), Insights into the physics of brain activity.

Mathematical models in biology – Introduction, types of models, levels of modeling, specificity of modeling in biology, Some standard models – unlimited growth,

Basic of biophysics – Mathematical fundamentals, Experimentation and computation, preliminary neurophysiology, principles of modeling, basic neuronal computation, patch clamp technique, Membrane equation (Fick's, Ohm's, Einstein's equations, Nernst potential), R-C circuits

Biophysics of computation – Neuronal computation, neuronal code, cellular basis of learning and memory, computation learning and memory in neuronal circuits.

REFERENCE BOOKS:

1. *Ed. Christopher Fall, Eric Marland, John Wagner and John Tyson. Computational cell biology. Springer. New York, 2005. ISBN 0-387-95369-8*
2. *Christof Koch. Biophysics of Computation. Oxford University Press: New York, New York, 1998 (ISBN 0-19-510491-9*
3. *Arthur T Johnson. Biology for Engineers. Draft Ed 2006. Book online here: http://www.bme.umd.edu/predbio.htm.*

MAT101 MATHEMATICAL FOUNDATIONS 3 1 0 4

Unit 1: Logic, Real numbers and the real line, Coordinates, lines and increments, Functions, shifting of graphs and trigonometric functions, Sets and functions, Mathematical induction, Finite and infinite sets.

Unit 2: The algebraic and order properties of $\mathbb{R}$, Absolute value and real line, The completeness property of , applications of supremum property, Intervals.

Unit 3: Limits and continuity- Rate of change of limits, rules for finding limits, Formal definition of limits, Extensions of the limit concept, Continuity, Tangent lines.

Unit 4: The derivative of a function, Rates of change, Implicit differentiation and rational exponents, Applications of derivatives, The mean value theorem (without proof), The first derivative test for local extreme values, Graphing with y' and y'', Linearization and differentials, Newton's method.

CAS Explorations and projects based on the topics

TEXTBOOKS:

1. *Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, 3rd edition, 2000, John Wiley & Sons.*
2. *Thomas and Finney, Calculus, 9th edition, Pearson education*
3. *MTTS Problem set*

MAT102 INTEGRATION AND ELEMENTARY NUMBER THEORY 3 1 0 4

Unit 1: Integration, curve tracing - plotting the graph of functions, Indefinite integrals, Differential equations, Initial value problems, Integration by substitution, Riemann sums and definite integrals, properties, Area and the mean value theorem (without proof), fundamental theorem (without proof), numerical integration

Unit 2: Area between curves, finding volumes by slicing, Volumes of solids of revolution, Lengths of plane curves, Areas of surface of revolution, moments and centers of mass, work, Fluid pressure and forces and other modeling applications.

Unit 3: Transcendental functions, inverse functions and their derivatives, natural logarithms and the exponential function, L'ôpital's rule, Inverse trigonometric functions, Derivatives of inverse trigonometric functions, Hyperbolic functions, first order differential equations and Euler's numerical method. Techniques of integration, integration by parts, Partial fractions, Improper integrals.

Unit 4: Elementary number theory: Divisibility theory of integers, The division algorithm, The greatest common divisor, The Euclidean algorithm, The Diophantine equation $ax + by = c$, Primes and their distribution, The fundamental theorem of arithmetic, The Sieve of Eratosthenes, The goldbach conjecture, Basic properties of congruence, Binary and decimal representation of integers, Linear congruence and Chinese remainder theorem, Fermat's theorem, Wilson's theorem.

CAS Explorations and projects based on the topics

TEXTBOOKS:

1. *Thomas and Finney. Calculus, 9th edition, Pearson education*
2. *Elementary number theory, David M. Burton, Tata Mc Graw-Hill edition, 1997*
3. *Gareth A. Jones and J. Mary Jones, Springer International student edition, 1998*
4. *MTTS Problem set*

MAT201 INTRODUCTORY ANALYSIS AND ALGEBRA 3 1 0 4

Unit 1: Sequences and series: Sequences and their limits, limit theorems, monotone sequences, subsequences and the Bolzano-Weierstrass theorem, Cauchy Criterion, Introduction to series

Unit 2: Limits: Limits of functions, limit theorems, extensions of the limit concept. Continuous functions, combination of continuous functions, continuous functions on some intervals, and uniform continuity

Unit 3: Simultaneous equation in two variables, discriminants, Seperation of repeated roots, cubic and quadratic equations

Unit 4: Linear equations and matrices: Systems of linear equations, Gaussian elimination, sums and scalar multiplication of matrices, products of matrices, Block matrices, Inverse of matrices, LDU factorization and applications. Determinants, properties, existence and uniqueness, cofactor expansion, Cramer's rule and applications.

CAS Explorations and projects based on the topics

TEXTBOOKS:

1. *Robert G. Bartle and Donald R. Sherbert, Introduction to Real analysis, 3rd edition, John Wiley and sons, Inc, 2000*
2. *Thomas and Finney, Calculus, 9th edition, Pearson education*
3. *Bernard R. Gelbaum and John M. H. Olmsted, Counter examples in Analysis, Dover publications, 2003*
4. *MTTS Problem set*
5. *Jin Ho Kwak and Sungpyo Hong, Linear Algebra, 2nd edition, springer 2004*
6. *D. E. Littlewood, A university Algebra, English Language Book Society, 1961*

MAT202 VECTORS AND ORDINARY DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1: Conic sections and quadratic equations, classifying conic sections by Eccentricity, quadratic equations and rotations, parameterization of plane curves, Calculus with parameterized curves, polar coordinates, Graphing in polar coordinates, polar equations for conic sections, Integration in polar coordinates

Unit 2: Vectors and analytic geometry in space: Vectors in plane, Cartesian co-ordinates and vectors in space, dot products, cross products, lines and planes in space, cylinders and quadratic surfaces, cylindrical and spherical coordinates

Unit 3: Vector valued functions and motion in space: Vector valued functions and space curves, Arc length and unit tangent vector, Curvature and torsion, planetary motion and Satellites.

Unit 4: Differential equations - Classification of differential equations, exact equations and integrating factors, Existence and uniqueness theorem (without proof), Numerical approximations: Euler's method, Ordinary linear differential equations of n-the order, solutions of homogeneous and non-homogeneous equations. Method of undetermined coefficients and variation of parameters, Applications - forced vibrations.

CAS Explorations and projects based on the topics

TEXTBOOKS:

1. *Thomas and Finney, Calculus, 9th edition, Pearson Education*
2. *Anton, Bivens, and Davis, Calculus, 7th edition, John wiley and sons, 2002*
3. *W.E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 7th edition, Wiley*
4. *S. L. Ross, Differential Equations, 3rd Edition, Wiley, 1984*

MAT203 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1: Groups, subgroups, isomorphism, automorphism, homomorphism, normal subgroups and factor groups.

Unit 2: Rings, homomorphism and isomorphism, the concept of field of quotients, polynomial rings, ideals, residue class rings, divisibility, prime ideals, Euclidean rings and principal ideal rings, factorization.

Unit 3: Transforms - Laplace transforms, Solution of initial value problems, Step functions, Impulse functions, Convolution integral. Fourier series, Fourier Convergence theorem, Even and odd functions.

Unit 4: Partial differential equations (p. d. e) Two point boundary value problems, Separation of variables, Heat equation, Wave equation and Laplace's equation and numerical solutions of p. d. e.

TEXTBOOKS:

1. *B. L. Van der Waerden, Algebra, Springer*
2. *I. N. Herstein, Topics in Algebra,2nd Edition*
3. *W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 7th edition, Wiley*
4. *S. L. Ross, Differential Equations, 3rd Edition, Wiley.*

MAT211 MULTIVARIATE CALCULUS 3 1 0 4

Unit 1: Multivariable Functions and Partial Derivatives - Functions of several variables, limits and continuity, partial derivatives, differentiability, linearization and differentials, partial derivatives with constrained variables, Directional derivatives, gradient vectors and tangent planes, extreme values and saddle points, Lagrange multipliers and Tailors formula.

Unit 2: Multiple integrals - Double integrals, areas, moments and center of mass, double integrals in polar form, triple integrals in rectangular coordinates, masses and moments in three dimensions, Triple integrals in cylindrical and spherical coordinates and substitutions in multiple integrals.

Unit 3: Integration in vector fields - Line integrals, vector fields, work, circulation and flux. Path independence, potential functions and conservative fields, green's theorem in the plane, surface area and surface integrals, parametrized surfaces. Stokes's theorem, The divergence theorem and a unified theory.

CAS Explorations and projects based on the topics.

TEXTBOOKS:

1. *Thomas and Finney, Calculus, 9th edition, Pearson education*
2. *Anton, Bivens, and Davis, Calculus, 7th edition, John wiley and sons, 2002*
3. *Jerrold E. Marsden Basic Basic multivariable calculus, springer 1993*
4. *Andrew Pressley, Elementary differential geometry, springer 2001*

MAT310 INTRODUCTORY REAL ANALYSIS 3 1 0 4

Unit 1: Differentiation: The derivative, The mean value theorem, L'Hospital rules, Taylor's theorem.

Unit 2: The Riemann integral, Riemann integrable functions, the fundamental theorem, approximate integration

Unit 3: Point wise and uniform convergence, Interchange of limits, the exponential and logarithmic functions, trigonometric functions

Unit 4: Absolute convergence, tests for absolute convergence, tests for non absolute convergence, series of functions

TEXTBOOKS:

1. *Robert G. Bartle and Donald R. Sherbert, Introduction to Real analysis, 3rd edition, John Wiley and sons, Inc. 2000*
2. *Bernard R. Gelbaum and John M. H. Olmsted, Counter examples in Analysis, Dover publications, 2003*
3. *MTTS Problem set*

MAT311 COMPLEX ANALYSIS 3 1 0 4

Unit 1: Complex numbers, algebra of complex numbers, functions of a complex variable, limits, continuity and differentiability. Cauchy-Riemann equations, harmonic functions. Elementary functions - exponential function, trigonometric functions, hyperbolic functions, logarithmic function, complex exponents and inverse trigonometric functions.

Unit 2: Conformal mappings, bilinear transformation, exponential and trigonometric transformations.
Complex integration - contour integral, Cauchy-Goursat theorem (with out proof), Cauchy integral formula, some consequences of Cauchy integral formula.

Unit 3: Sequences and series - sequences, series, sequences of functions, series of functions, power series, uniform convergence of power series, Taylor series,

zeros of analytic functions, Laurent series, integration and differentiation of power series.

Unit 4: Singularities and residues - classification of singularities, residues, poles and zeros, behavior of functions at infinity.

(Importance for working problems rather than proving theorems)

TEXTBOOK:

H.S. Kasana, Complex Variables, Theory and applications, 2nd edition, prentice hall India

MAT322 INTRODUCTION TO DISCRETE MATHEMATICS 3 0 0 3

Logic, Mathematical Reasoning and Counting: Logic, Propositional Equivalence, Predicate and Quantifiers, Functions, Mathematical Induction, Recursive Definitions, Recursive Algorithms, Basics of Counting, Pigeonhole Principle, Permutation and Combinations.

Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion.

Relations and Their Properties, N-Ary Relations and Their Applications, Representing Relations, Closure of Relations, Equivalence Relations, Partial Ordering.

Graph Theory: Introduction to Graphs, Graph Operations, Graph and Matrices, Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest Path Problem, Planar Graph, Graph Colourings.

TEXTBOOKS:

1. *'Discrete and Combinatorial Mathematics', R.P. Grimaldi, Pearson Education, Asia, New Delhi, 2002, Fourth Edition.*
2. *'Discrete Mathematics with Applications', Thomas Koshy, Academic Press, 2009*

REFERENCES:

1. *'Discrete Mathematics and its Applications', Kenneth H. Rosen, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2004, Sixth Edition.*
2. *'Elements of Discrete Mathematics', Liu, TMH, 2004.*
3. *'Essence of Logic', John Kelley, PHI, 2002*

MAT331 LINEAR ALGEBRA AND DISCRETE MATHEMATICS 3 1 0 4

Unit 1: Vector spaces, n spaces, subspaces, bases and dimension, rank and nullity, invertibility, applications.

Unit 2: Linear transformations - Basic properties, matrices of linear transformations, vector space of linear transformations, change of bases, similarity, applications. Polynomials, the zeros of a polynomial, and factorization.

Unit 3: The basics of counting, the pigeonhole principle, permutations and combinations, generalized permutations and combinations, recurrence relations, divide and conquer relations, generating functions and inclusion-exclusion.

Unit 4: Introduction to Graphs, representing graphs and graph isomorphism, connectivity, Euler and Hamiltonian paths, planar graphs, graph coloring, trees, trees and sorting, spanning trees and minimum spanning trees.

TEXTBOOKS:

1. *Jin Ho Kwak, Sungpyo Hong, Linear Algebra, Springer 2nd edition, 2004*
2. *Kenneth Hoffman and Ray Kunze, Linear Algebra, 2nd edition*
3. *Kenneth H. Rosen, Discrete mathematics and its applications, McGraw-Hill international edition, 4th edition, 1999*

MAT332 INTRODUCTION TO OPERATIONS RESEARCH 3 0 0 3

Unit 1: Linear Programming: Introduction, Mathematical Formulations, Solutions, Graphical Method, Simplex Method, Artificial variables, Big M & Two Phase Method, Variants in Simplex Method, Duality Theory and Problems, Dual Simplex Method.

Unit 2: Transportation and its variants: Definition, Transportation Algorithms and Solutions, Assignment Model, Hungarian Method, Traveling Salesman Problem.

Unit 3: Game theory: Two-Person Zero-Sum Games, The Maxi-Min-Mini-Max principle, Games without saddle point-Mixed Strategies, Dominance property, Arithmetic method for non games, General solution of mxn rectangular games.

Unit 4: Work Break down Structures, Network logic, Critical Path, CPM Vs PERT, Slack and Floats.

TEXTBOOKS:

1. *Hamdy A Taha, "Operations Research – An introduction", Macmillan Publishing Co., Sixth Edition, 2001.*
2. *Sharma, S.D. "Operations Research", Kedar Nath Ram Nath & Co, 2004*

REFERENCE TEXTS

1. *Kanti Swarup, P K Gupta and Manmohan, "Operations Research", Sultan Chand and Sons, 1991.*
2. *F.Hiller and G.J.Lieberman, "Introduction to Operations Research", Holden Day Inc., 1990.*

MAT411 ADVANCED COMPLEX ANALYSIS 4 0 0 4

Spherical representation, point at infinity. Differentiation, Cauchy-Riemann equations, power series and its derivative, Harmonic functions. Conformality and other properties of analytic functions. Linear fractional transformations. Cauchy's theorem for a convex domain, Cauchy's integral formula, Cauchy estimate, power series expansion, Morera's theorem, Liouville theorem, Fundamental theorem of Algebra. Laurent expansion, Singularities, Meromorphic functions. Cauchy's Theorem, Residue calculus, application to some explicit integrals. Maximum modulus principle. Harmonic functions, Poisson integral formula, Harnack's theorem, mean value property, the Schwartz reflection principle.

TEXTBOOKS:

1. *L. Ahlfors, Complex Analysis, McGraw-Hill.*
2. *J.B. Conway, Functions of one complex variable, Springer.*
3. *D. Sarason, Notes on Complex Function Theory, Hindustan Book Agency.*

MAT413 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS 4 0 0 4

Review of solution methods for first order as well as second order equations. Power Series methods with properties of Bessel functions and Legendre polynomials. Existence and Uniqueness of Initial Value Problems, continuation of solutions and maximal interval of existence. Higher Order Linear Equations and linear Systems, fundamental solutions, Wronskian, variation of constants, matrix exponential solution, behaviour of solutions. Two Dimensional Autonomous Systems and Phase Space Analysis: critical points, proper and improper nodes, spiral points and saddle points. Asymptotic Behavior, stability by Lyapunov methods, Nonlinear systems, conservative systems, Poincare-Bendixson theorem. Boundary Value Problems for Second Order Equations: Green's function, Sturm comparison theorems and oscillations, eigenvalue problems.

TEXTBOOKS:

1. *G.F. Simmons, Differential Equations with Applications and Historical Notes, McGraw-Hill.*
2. *W. Hurewicz, Lectures on Ordinary Differential Equations.*

MAT414 TOPOLOGY 4 0 0 4

Topological spaces, Basis for a topology, The order topology, Subspace topology. Closed sets and Limit points. Continuous functions. The product topology, Metric topology, Quotient topology. Connected spaces, Connected sets in $\mathbb{R}$. Components and path components, Compact spaces, Compactness in metric spaces, Local compactness, One point compactification. Separation axioms, Urysohn's lemma,

Urysohn's metrization theorem, Tietz extension theorem. The Tychonoff theorem, Completely regular spaces, Stone-Czech compactification.

TEXTBOOKS:

1. *J.R. Munkres, Topology: A First Course, Prentice Hall.*
2. *G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill.*

MAT420 LINEAR ALGEBRA 4 0 0 4

Vector Spaces: basis, dimension, direct sums, duals, double dual. Matrices and Linear transformation: Linear map as a matrix, rank of a linear map, nullity. Eigenvalues, eigenvectors, minimal and characteristic polynomials, Cayley-Hamilton theorem, Simultaneous Triangulation and diagonalisation, Jordan canonical form. Inner products spaces, hermitian, unitary and normal operators. Modules, Submodules, Direct sums and Free modules, Modules over Principle Ideal Domains.

TEXTBOOKS:

1. *K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall.*
2. *Dummit and Foote, Abstract Algebra, Wiley.*

MAT422 ALGEBRAIC NUMBER THEORY 3 0 0 3

UNIT 1: Algebraic background - Algebraic numbers - Quadratic and cyclotomic fields - Factorization into irreducibles (I).

UNIT 2: Factorization into irreducibles - Examples of non-unique factorization into irreducibles, Prime factorization, Euclidean domains, Euclidean quadratic fields. Theorem 4.20 of the equation $y^2 + 4 = 2^n$. (Ramanujan-Nagell Theorem excluded). Ideals - Lattices - Minkowski's theorem.

UNIT 3: The Space L^n - Class-group and class-number - Fermat's last theorem, Some history. Elementary considerations. Kummar's Lemma. (Kummer's theorem excluded) - Dirichlet's unit theorem.

TEXTBOOK:

I. STEWART & D. O. TALL: ALGEBRAIC NUMBER THEORY (2nd Edn.), Chapman & Hall, (1987)

REFERENCES:

1. *P. Samuel: Theory of Algebraic Numbers, Hermen Paris Houghton Mifflin, (1970).*
2. *S. Lang: Algebraic Number Theory, Addison Wesley Pub Co., Reading, Mass. (1968).*
3. *D. Marcus: Number Fields, Universitext, Springer Verlag, NY, (1978).*
4. *T.I.F.R. Pamphlet No. 4: Algebraic Number Theory (Bombay, 1966).*
5. *Harvey Cohn, Advanced Number Theory, Dover Publications Inc., NY, (1980).*
6. *Andre Weil: Basic Number Theory, (3rd Edn.)Springer Verlag, NY, (1974).*

MAT430	DISCRETE MATHEMATICS	3 0 0 3

Propositional Logic, Equivalences, Predicates and Quantifiers, Sets, Functions and growth of functions. Basic Counting Principles, Generating Functions, Recurrence Relations, Inclusion - Exclusion Principles, Euler's phi-function and its Application to Cryptography. Relations and their properties, n-ary relations, Equivalence relations. Graphs, Bipartite Graphs, Planar graphs, Eulerian and Hamiltonian Graphs, Graph coloring, Trees, Minimum Spanning Trees, Depth First search, Breadth First Search, Shortest Path Algorithms. Finite Automata: Languages Accepted by Finite state Machines, Regular Expressions, Pumping Lemma for Regular Languages.

TEXTBOOK:

Kenneth H. Rosen, Discrete Mathematics and its Applications, McGraw-Hill.

MAT431	CALCULUS OF VARIATIONS	3 0 0 3

UNIT 1

ELEMENTS OF THE THEORY: Functionals. Some simple variational problems. Function spaces. The variation of a functional. A necessary condition for an extremum. The simplest variational problem. Euler's equation. The case of several variables. A simple variable end-point problem. The variational derivative. Invariance of Euler's equation.

FURTHER GENERALISEATIONS: The fixed end-point problem for unknown functions. Variational problems in parametric forms. Functional depending on higher order derivatives. Variational problems with subsidiary conditions.

UNIT 2

THE GENERAL VARIATION OF A FUNCTIONAL: The derivation of the basic formula. End-points lying on two given curves or Surfaces. Broken extremals. The Weierstrass-Erdmann conditions.

THE CANONICAL FORM OF THE EULER EQUATIONS AND RELATED TOPICS: The canonical form of Euler Equations. First integrals of Euler equations. The Legendre transformations. Canonical transformations. Noether's theorem. The principle of least action. Conservation laws. The Hamilton-Jacobi equation. Jacobi's theorem.

THE SECOND VARIATION. SUFFICIENT CONDITION FOR A WEAK EXTREMUM: Quadratic functionals. Second variation of functional. The formula for second Variation. Legendre's condition. Analysis of the quadratic functional $\int (Ph'^2 + Qh^2)\, dx$. Jacobi's necessary condition. More on Conjugate points. Sufficient condition for a weak Extremum. Generalization to n unknown functionals. Connection between Jacobi's condition and the theory of quadratic forms.

UNIT 3

FIELDS, SUFFICIENT CONDITIONS FOR A STRONG EXTREMUM: Consistent boundary conditions. General definition of a field. The field of a Functional. Hilbert's invariant integral. The Weierstrass E-Function. Sufficient conditions for a strong extremum.

VARIATIONAL PROBLEMS INVOLVING MULTIPLE INTEGRALS: Variation of a functional defined on a fixed region. Variational derivation of Equations of motion of continum mechanical systems. Variation of a functional defined On a variable region. Applications to Field theory.

TEXTBOOK:

M.GELFAND & S.V. FOMIN, CALCULUS OF VARIATIONS, Prentice Hall Inc. N.Y (1963)

REFERENCES:

1. *Bliss G.A: Calculus of Variations, Open Court Pub Co. Chicago (1925)*
2. *Bliss G.A: Lectures on Calculus of Variations, Univ of Chicago Press, Chicago (1946)*
3. *Bolza O.: Lectures on Calculus of Variations, G.E. Stechert & Co., NY (1931)*
4. *Courant R and Hilbert D: Methods of Mathematical Physics, vol I, Wiley Eastern Reprint (1975)*
5. *Elsgolc L: Differential Equations and the Calculus of variations, MIR Publishers, Moscow (1973)*
6. *Goursat E: Course d' Analyse, Paris (1910,1911)*
7. *Morse M: The Calculus of Variations in the large, Amer Math Soc (1934)*

MAT505	DIFFERENTIAL GEOMETRY	3 0 0 3

Curves in the plane and in space, arc-length, reparametrization, level curves Vs parametrized curves, curvature, plane curves, space curves - global properties of curves, the isoperimetric inequality, the four vertex theorem, surfaces in three dimension, smooth surfaces, tangents, normals and orientability, quadratic surfaces, triply orthogonal systems, applications of inverse function theorem, the first fundamental form, lengths of curves on surfaces, isometric surfaces, conformal mapping of surfaces, surface area, equiareal maps and a theorem of Archimedes, curvature of surfaces, the second fundamental form, the curvature of curves on a surface, the normal and principal curvatures, geometric interpretation of principal curvatures, The Gaussian curvature and the mean curvature, the pseudosphere, flat surfaces, surfaces of a constant mean curvature, Gaussian curvature of a compact surfaces, the Gauss map.

TEXTBOOK:

Andrew Pressley, Elementary differential geometry

MAT501	ANALYTIC NUMBER THEORY	3 0 0 3

The fundamental theorem of Arithmetic; Arithmetical function and Dirichlet multiplication; Congruences, Chinese Remainder theorem; Quadratic residues,

Reciprocity law, Jacobi Symbol; Primitive roots, existence and number of primitive roots.

TEXTBOOK:

Tom M.Apostol, *Introduction to Analytic Number Theory*, Springer – Verlag

REFERENCES:

1. Emil Grosswald, *Topics from the theory of numbers*, Birkhauser
2. G.H Hardy and E.M Wright, *Introduction to the theory of numbers*, Oxford

MAT519 REAL ANALYSIS II 4 0 0 4

Riemann-Stieltjes integral, upper and lower sums as area under a curve. Integrability of continuous functions, Fundamental theorem of Calculus, integration by parts, rectifiable curve. Sequence and series of functions, Uniform convergence, limit of continuous and differentiable functions under uniform convergence, integration under uniform convergence. Equicontinuity, Stone-Weierstrass theorem. Power series: Basic theorems about convergence and continuity of a power series, radius of convergence, behaviour at the end points. Exponential and trigonometric functions. Fourier series, basic convergence theorem, Parseval's theorem. Functions of Several variables: Derivative of a function from $\mathbb{R}^n$ to $\mathbb{R}^m$ as a linear map, partial derivative. Chain rule, inverse and implicit function theorems.

TEXTBOOKS:

1. W. Rudin, *Principles of Mathematical Analysis*, 3rd edition, McGraw-Hill, 1976.
2. Terence Tao, *Analysis II*, Hindustan Book Agency
3. T. Apostol, *Mathematical Analysis*, Narosa.
4. H.L. Royden, *Real Analysis*, Prentice-Hall

MAT511 MEASURE AND INTEGRATION 4 0 0 4

σ-algebras of sets, measurable sets and measures, extension of measures, construction of Lebesgue measure, integration, convergence theorems, Radon-Nikodym theorem, product measures, Fubini's theorem, differentiation of integrals, absolutely continuous functions (as e.g., in Royden, Chapter 5). L^p-spaces. Riesz representation theorem for the space $C[0, 1]$.

TEXTBOOKS:

1. H.L. Royden, *Real Analysis*, Prentice-Hall.
2. W. Rudin, *Real and Complex Analysis*, McGraw-Hill.

MAT512 FUNCTIONAL ANALYSIS 4 0 0 4

Normed linear spaces, Continuity of linear maps, Hahn-Banach theorem, Banach spaces, Uniform boundedness principle, open mapping theorem, closed graph theorem, Spectrum of a bounded operator. Duals and transposes, Computing the dual of well-known Banach spaces. Inner product spaces, Hilbert spaces, Orthonormal basis, Projection theorem and Riesz Representation Theorem. Adjoint operators, Normal, Unitary and self-adjoint operators.

TEXTBOOKS:

1. B.V. Limaye, *Functional Analysis*, Wiley
2. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill

MAT513 THEORY OF PARTIAL DIFFERENTIAL EQUATIONS 4 0 0 4

First order equations, Analytic solutions and approximation methods, Cauchy problem for the Quasi-linear equation. Second order equations, Characteristics for linear and quasi-linear second order equations, propagation of singularities, One dimensional wave equation. The Cauchy problem, Cachy-Kowalevski theorem, Holmgren's theorem. The Laplace equation, Fundamental solutions, The maximum principle, Dirichlet problem, Green's function and Poisson's formula. Wave equation in n-Dimensional space, method of spherical means, Hadamard's method, general Cauchy problem, boundary value problems. Heat equation, maximum principle, uniqueness and regularity.

TEXTBOOK:

F. John, *Partial Differential Equations*

MAT514 OPERATOR THEORY 3 0 0 3

Bounded Linear Maps on Banach Spaces: Spectrum of a Bounded operator, Compact linear maps, Spectrum of a compact operator, Fredholm alternative.

Bounded Operators on Hilbert Spaces: Bounded operators and adjoints, Normal Unitary and Self – adjoint operators, spectrum and Numerical Range, Compact Self – adjoint operators; Spectral Theorem, Banach Algebras

REFERENCES:

1. Limaye, B. V. *Functional Analysis*, (Second Edition), New Age Int. Ltd. New Delhi 1996
2. Rudin W. *Functional Analysis*, (Second Edition), Mc Graw Hill, N. Y. 1991.
3. Bhatia R. *Notes on Functional Analysis*, (Texts series), Hindustan Book Agency, New Delhi, 2009

MAT515 INTEGRAL EQUATIONS 3 0 0 3

UNIT 1: Fredholm Equations. Concept of integral equations - Scalar product and norm – Orthogonality; Fredholm operator and its degree. Iterated Kernel - Method of successive; Approximations - Volterra equations - Abel equations - Concept of resolvent - Systems of linear algebraic equations – Integral equations with degenerate kernels - General case of Fredholm equations - Conjugate Fredholm equation - Fredholm theorems.

UNIT 2: Continuation of Fredholm Equations; Resolvent - Continuous solutions of integral equations - Systems of integral equations - Examples of non-Fredholm; integral equations - Riesz Schauder Equations; Fundamental concepts of operators - Method of successive approximations for Equations with conjugate bounded operators - Completely continuous operators - Solution of Riesz - Schander equations - Extension of Fredholm theorems; Symmetric Integral Equations; Symmetric Kernels - Fundamental theorems on symmetric equations - Theorem on existence of a characteristic constants – Hilbert - Schmidt theorem - Solutions of symmetric integral equations.

UNIT 3: Bilinear series - Bilinear series for iterated kernel - Resolvent of a symmetric kernel - Extremal properties of characteristic constants and proper functions; Applications of integral equations; Boundary value problem for an ordinary differential equation - Characteristic constants and proper functions of an ordinary differential equations - Proof of the Fourier method.

TEXTBOOK:

MIKHLIN, S.G., LINEAR INTEGRAL EQUATIONS, Hindustan Pub. Corporation, Delhi (1960)

REFERENCES:

1. *M.Krasnov , A.Kiselev & G.Makarenko: Problems and Exercises in Integral Equations, Mir Publishers, Moscow (1971)*
2. *R.Courant and D.Hilbert: Methods of Mathematical Physics, Wiley Eastern Pvt. Ltd. New Delhi*
3. *F.Riesz and B.Sz. Nagy: Functional Analysis, Frederick Ungar Publishing Co. NY (1955)*

MAT520 ADVANCED ALGEBRA 4 0 0 4

Group theory, Group acting on sets, Cayley's theorem, Cauchy's theorem, Class equation, Sylow theorems, Semidirect product. Elementary notions of rings, ideals, prime ideals, maximal ideals, quotients, integral domains, ring of fractions, PID, UFD. Field theory, Algebraic and Transcendental extensions, Splitting fields, Ruler and Compass constructions, Symbolic adjunction of roots, Finite fields. Galois theory, Solvability of equations by radicals.

TEXTBOOKS:

1. *M. Artin, Algebra, Prentice Hall*
2. *Dummit and Foote, Abstract Algebra, Wiley*

MAT521 ALGEBRAIC TOPOLOGY 3 0 0 3

UNIT 1: Geometric Complexes and Polyhedra: Introduction, Examples. Geometric Complexes and Polyhedra; Orientation of geometric complexes. Simplicial Homology Groups: Chains, cycles, Boundaries and homology groups. Examples of homology groups; The structure of homology groups; The Euler Poincare's Theorem; Pseudomanifolds and the homology groups of S^n.

UNIT 2: Simplicial Approximation: Introduction; Simplicial approximation; Induced homomorphisms on the Homology groups; The Brouwer fixed point theorem and related results; The Fundamental Group: Introduction; Homotopic Paths and the Fundamental Group; The Covering Homotopy Property for S^1;

UNIT 3: Examples of Fundamental Groups; The Relation Between $H_1(K)$ and $\pi_1(K)$; Covering Spaces: The definition and some examples. Basic properties of covering spaces. Classification of covering spaces. Universal covering spaces. Applications.

TEXTBOOK:

FRED H. CROOM, BASIC CONCEPTS OF ALGEBRAIC TOPOLOGY, UTM, Springer Verlag, NY(1978)

REFERENCES:

1. *Eilenberg S and Steenrod N, Foundations of Algebraic Topology , Princeton Univ. Press (1952)*
2. *S.T. Hu: Homology Theory, Holden-Day (1968)*
3. *S.T. Hu: Homology Theory, Academic Press (1959)*
4. *Massey W.S: Algebraic Topology: An Introduction, Springer Verlag NY (1977)*
5. *C.T.C. Wall: A Geometric Introduction to Topology, Addison-Wesley Pub Co Reading Mass (1972)*

MAT530 CONTINUUM MECHANICS 3 0 0 3

Description of Continua and Kinematics, Forces in a Continuum, The Polar decomposition theorem, Continuum Deformation, Geometrical Restrictions on the form of Constitutive equations, Constitutive equations for fluid, Elastic and Thermo-elastic materials, Shear Flow solutions of Reiner-Rivlin Fluids, The Theorem of Classical Linear Elasticity for Isotropic solids.

REFERENCE:

Hunter, S.C., Mechanics of Continuous Media

MAT531 ADVANCED OPERATIONS RESEARCH 3 0 0 3

Linear programming: Mathematical formulation of industrial problems in LPP models, Simplex method, Theorems on Simplex method, Two phase method, Big M method, Degeneracy in LPP.

Concept of duality in LPP, Dual simplex method, Fundamental theorem of duality, Sensitivity Analysis, Linear goal programming: Graphical method and Simplex method, Integer programming: Cutting plane method, Branch and bound method.

Assignment problem, Hungarian method for solution, crew assignment problem, Travelling salesman problem, Transportation problem: Basic feasible solution, optimal solution by stepping Stone method and modified distribution method, Transhipment problem, Degeneracy in transportation problem and its resolution.

Game theory: Two persons zero sum game, Maximin (Minimax) criterion, Games with mixed strategies, graphical solution, Equivalence of the rectangular game and linear programming, solution by simplex method, algebraic method, Iterative method, Sequencing problem of n jobs through two machines, three machines, solution by Gantt chart, Solution by graphical method of processing two jobs through m machines, n jobs through m machines.

Nonlinear programming, Unconstrained problems of maxima & minima, Necessary and sufficient condition for an n variable function to have extrema, Concept of positive definite, extremum Hessian matrix, Newton-Raphson method, Kuhn-Tucker condition for constrained optimization, Quadratic programming, graphical method, Wolfe method.

TEXT / REFERENCES:

1. H.A. Taha, *Operations Research: An introduction (Sixth edition)*, Prentice Hall of India Pvt. Ltd., 2001.
2. G. Hadley, *Linear Programming*, Narosa publication house, 1995.
3. Kanti Swaroop, P.K. Gupta, and Man Mohan, *Operations Research*, Sultan Chand and Sons, New Delhi.
4. F.S. Hillier and G.J. Lieberman, *Introduction of Operations Research*, McGraw Hill International Edition, Industrial Engineering series, 1995.

MAT540 COMBINATORICS 3 0 0 3

Permutations and Combinations, Application to Probability.
The Principle of Inclusion and Exclusion, Mobious Inversion, Partially Ordered sets and their mobious functions, Generating Functions and Recursions, Partitions, Identities and Arithmetic Properties, Gauss-Jacobi identity, Jacobi identity, Asymptotic

Properties of P(n). Distinct Representatives: The Theorems of P.Hall and D.Konig. Simultaneous representatives, The Permanent Proof of the Van der Waerden conjecture, Permanents of Integral Matrices with Constant Line Sum.
Ramsey's Theorem: Statement of the Theorem, Application of Ramsey's Theorem.
Hadamard Matrices: Paley's Constructions, Williamson's method, An Infinite class of Williamson's Matrices, Three Recent Methods.

TEXTBOOK:

Marshall Hall Jr.: Combinatorial Theory, 2nd Edition (Wiley-Inter Science Publications)

REFERENCE BOOKS

1. *John Riordan: An Introduction to Combinatorial Analysis (Wiley Publications).*
2. *Gerald Berman and K. D. Fryer: Introduction to Combinatorics (Academic Press).*
3. *V. K. Balakrishnan: Schaum's outline series Theory and Problems of Combinatorics (Mc-Graw Hill).*

MAT541 ADVANCED GRAPH THEORY 3 0 0 3

Traversability - Eulerian graphs, Hamiltonian graphs.
Line Graphs - Some properties of line graphs, Characterization of line graphs, Special line graphs, Line graphs and traversability.
Factorization, Planarity - Plane and planar graphs, Euler's formula, Characterizations of planar graphs, Nonplanar graphs, Outerplanar graphs.
Colorability - the chromatic number, Five color theorem.
Matrices – The adjacency matrix, The incidence matrix, The cycle matrix.
Groups – The automorphism group of a graph, Operation on Permutation groups, The group of a composite graph, Graphs with a given group, Symmetric graphs, Highlysymmetric graphs.
Domination Theory - Domination numbers, Some elementary properties.

REFERENCES:

1. *F. Harary – Graph Theory, Addison Wesley Reading Mass, 1969.*
2. *N. Deo – Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 1997.*
3. *K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi, 1994.*
4. *G. Chartand and L. Lesniak – Graphs and Digraphs, Wadsworth and Brooks, 2nd Ed.,*
5. *Clark and D. A. Holton – A First Look at Graph Theory, Allied publishers.*
6. *D. B. West – Introduction to Graph Theory, Pearson Education Inc., 2001, 2nd Ed.,*
7. *J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier, 1976.*

MAT542 AUTOMATA THEORY 3 0 0 3

SETS, RELATIONS AND LANGUAGES
"If, Then" and its relatives, Sets, Relations and Functions, Special Types of Binary

Relations, Closures; Finite and Infinite Sets, Three Fundamental proof Techniques, Alphabets and Languages, Finite Representation of Languages.

FINITE AUTOMATA
Deterministic Finite Automata, Nondeterministic finite automata, Equivalence of Deterministic and Nondeterministic Finite Automata, Properties of the Languages accepted by Finite Automata, Finite Automata and Regular Expressions, Proofs that Languages Are and Are not Regular.

CONTEXT-FREE LANGUAGES
Context-free Grammars, Regular Languages and Context-Free Languages, Pushdown Automata.

REFERENCE BOOKS:

1. *Daniel Long J.C., Theory of Finite Automata with an Introduction to Formal Languages, Prentice Hall.*
2. *Hopcroft J. and Ullman J.D., Introduction to Automata Theory, Languages and Computation.*

MAT599	PROJECT	10 cr

During the last semester of the course, each student must undergo a dissertation/ project work of ten credits under the supervision of a faculty member of the Department. It can be in any areas of Mathematics according to the interest of the student as well as the supervisor. It has two parts: Investigating and understanding a topic, and producing a coherent piece of text that describes the results of the investigation. Both parts are typically new for students, and highly instructive. While studying the topic, the student must work independently, understand texts that may be difficult or short, and possibly solve unfamiliar problems that are not pre-chewed like class-room or textbook examples. The results of the investigation have to be explained clearly and informatively, in an appropriate tone and style, and in proper form. Writing well is hard work, and an activity that must be learned. The M.Sc dissertation provides such a learning opportunity. Through the dissertation/ project work the student will acquire academic qualifications that enable him/her to take part in modern research and knowledge dissemination.

MPJ397 / MPJ398	SEMINAR	0 0 2 1 / 0 0 2 1

Seminars shall be given from both the areas of Mathematics and Physics and one credit is awarded together for both in each semester. In this course, students present and discuss the subject matter, with faculty guidance. Topics presented by the students include the fundamental topics from both the areas. Also students are exposed to areas of Mathematics and Physics not usually covered in courses

and students take turns in giving lectures. The objective of these seminars is to provide the students with training in the verbal and written communication of topics in Mathematics and Physics.

MPJ399	PROJECT *(for Exit Option students only)*	8 cr *(for 2009 batch)* 10 cr *(for 2010 batch onwards)*

Students interested in exercising the exit option at the end of the 6th semester shall decide on it at the end of the fourth semester. Such students should do an eight credit project with two components viz., (i) Mathematics (ii) Physics of equal number of credits. It can also be from a combined area of Mathematics and Physics. This shall be a 6 credit project for the batches admitted from 2010 onwards and shall be an 8 credit project for 2009 admissions.

The proposed project work shall get started at the beginning of the fifth semester and is to be credited during the sixth semester. The project work should be done under the supervision of faculty members from the respective disciplines. Projects can be something like reading some text books and writing it elaborately or it can be some survey projects and interpretation of results or making working models in Physics etc. At the end of the 5th semester there shall be a review of the ongoing project. Also the student should give a presentation of the project at the end of the sixth semester.

MPJ450	SIMULATION LAB	0 0 3 1

Graph plotting, Simulation experiments etc based - Physics and Mathematics problems – using MatLab/Mathematica

MPJ497	SEMINAR	0 0 2 1

Seminars shall be given from both the areas of Mathematics and Physics and one credit is awarded together for both in each semester. In this course, students present and discuss the subject matter, with faculty guidance. Topics presented by the students include the fundamental topics from both the areas. Also students are exposed to areas of Mathematics and Physics not usually covered in courses and students take turns in giving lectures. The objective of these seminars is to provide the students with training in the verbal and written communication of topics in Mathematics and Physics.

PHY110 MECHANICS 3 1 0 4

Physical quantities, dimensional analysis, kinematics in 1D- instantaneous velocity and acceleration. Kinematics in 3-D: vector algebra, velocity and acceleration in Cartesian, polar and cylindrical coordinate systems. Circular motion and centripetal acceleration.

Newton's laws and applications: concepts of momentum, energy, angular momentum, work and potential energy. Vibrational motion; conservative forces; contact forces – friction, stress, viscous drag, etc. Pseudo forces and fundamental forces. Mathematical aside: work as a line integral, collisions and conservation laws; potential energy and conservation of energy; stokes theorem, curl, irrotational force fields.

Frames of Reference: Galilean transformation, absolute and relative velocities, inertial and non-inertial frames, rotating frames, centrifugal and coriolis forces; Foucault pendulum.

Rigid body motion, fixed axis rotations, rotation and translation, moments of inertia and products of inertia, principal moments and axes.

Motion under a center force, Kepler's laws. Gravitational law and field, conservative and non conservative forces, system of particles, center of mass, equations of motion for center of mass and relative motion, elastic and inelastic collision, conservation of linear and angular momentum. Variable mass systems.

Elasticity, Hooke's law and elastic constants of isotropic solid, stress energy. Kinematics of moving fluids, equation of continuity, Euler's equation, Bernoulli's theorem, viscous fluids, surface tension and surface energy, capillarity.

TEXTBOOK:

David Halliday, Robert Resnick, and Jearl Walker Fundamentals of Physics (8th Edition), John-Wiley (2008)

REFERENCES:

1. *Raymond A.Serway and Jerry S.Faughn, College Physics (7th edition), Thomson Brooks/ Cole, USA(2009)*
2. *Francis .W.Sears, Mark.W.Zemansk and Hugh. D.Young,University Physics(sixth edition), Pearson*
3. *Richard P.Feynmann, Robert B.Leighton and Matthew Sands, Feynmann Lectures on Physics(Vol.I), Narosa (2008)*
4. *DS Mathur, Mechanics, S.Chand and C. India (2008)*

PHY120 ELECTRICITY AND MAGNETISM 3 1 0 4

Brief review of vector calculus. Electrostatics: Coulomb's Law, Gauss' law and applications. Energy conservation, electrostatic field and potential, divergence and curl of E, conductors and capacitors, dielectrics, dielectric polarization,volume and surface charges, electrostatic energy.

Laplace's equation and (first) uniqueness theorem, polarization, bound charges, electric displacement and boundary conditions, linear dielectrics, force on dielectrics.

Current, resistance and electromotive force. Direct current circuits and instruments.

Magnetic field, motion of charges in electric and magnetic fields, current density, curl and divergence of B, Biot-Savart law, magnetic field along a long straight conductor, force between parallel conductors, magnetic field of a circular loop, Ampère's law and applications.

Vector potential, magnetic fields and displacement currents. Induced emf, Faraday's law of electromagnetic induction, Lenz's Law, self and mutual inductance, eddy currents. The R-L circuit, L-C Circuit, RLC circuits, alternating currents. Simple average and rms values. AC circuits: series resonance, parallel circuits, the transformer.

Magnetic fields in matter: magnetization, bound currents and bound pole densities, magnetic field H, magnetic susceptibility, ferro-, para-, and dia-magnetism,magnetic domains, hysteresis, the magnetic field of earth.

Displacement currents, Maxwell's equations and plane electromagnetic waves. Poynting's theorem, conservation laws. Reflection and refraction at a dielectric interface, transmission and reflection coefficients (normal incidents only) Lorentz force and motion of charged particles in electric and magnetic fields. Electromagnetic waves.

TEXTBOOK:

David Halliday, Robert Resnick, and Jearl Walker Fundamentals of Physics (8th Edition), John-Wiley (2008).

REFERENCES

1. *Francis .W. Sears, Mark .W. Zemansk and Hugh. D. Young, University Physics(8th edition) Pearson*
2. *Richard .P. Feynmann, Robert .B. Leighton and Matthew Sands, Feynmann Lectures on Physics(Vol.I), Narosa (2008)*
3. *Raymond .A. Serway and Jerry .S.Faughn, College Physics(7th edition), Thomson Brooks/ Cole, USA(2009)*
4. *David .J. Griffith, Introduction to electrodynamics(3rd Edition), John Wiley(1999)*

PHY180	PHYSICS LAB I	0 0 3 1

List of experiments:
1. Surface Tension – Capillary Rise Method
2. Coefficient of Viscosity - Stoke's Method
3. The Torsion Pendulum
a. Moment of inertia of the Disc
b. The Rigidity Modules of the Material of Wire
4. Young's Modulus – Uniform Bending
5. Spectrometer – Dispersive Power
6. Liquid Lens – Refractive Index of liquid
7. Laser - Wave length of Laser beam
8. Laser - Slit Width of the given slit
9. Magnetometer – Measurement of magnetic flux

PHY181	PHYSICS LAB II	0 0 3 1

List of experiments:
1. Lee's disc – Thermal Conductivity of a bad conductor
2. Solar cell characteristics.
3. Potentio meter – Comparison of emfs.
4. Conversion of galvanometer to Voltmeter
5. Field along the axis of a coil
6. Measurement of Laser beam divergence.
7. Spectrometer – i – d – curve.
8. Newton's rings.
9. Meter bridge - Resistance measurement
10. Ref. index of a Transport bar
11. Electric field distribution

PHY205	HISTORY AND PHILOSOPHY OF SCIENCE	2 0 0 2

Introduction
A. Philosophy of science
History, Science and Society; Historical Knowledge and Knowledge of History; The Indian approach to science; Methodology of Indian Mathematics
B. Scientific Ideas from Non-Western Civilizations
a. From India
Indian contribution to science and technology; Pioneers in modern science; Science and Technology in Post Independence India
b. From other Civilizations

China and Islam
C. Development of Modern Science
18th century; 19th century; 20th century;
D. Conclusion

PHY210	HEAT AND THERMODYNAMICS	3 1 0 4

Concept of temperature and Zeroth law of thermodynamics - thermometers and temperature scales, thermal expansion of solids and liquids, macroscopic description of an ideal gas, Avogadro number and the ideal Gas Law. The kinetic theory of gases.

Heat - mechanical equivalent of heat, specific heat, conservation of energy, calorimetry. Latent heat and phase changes, heat transfer - conduction, convection and radiation - examples. Stefan-Boltzman law - the ideal radiator.

Thermal properties of matter - equations of state, pVT surface for an ideal gas, real substance, phase diagrams-triple point and critical point-vapour pressure, the bubble chamber.

State variables – The first law of thermodynamics - energy and work in thermodynamics, work and heat in volume changes, internal energy. Adiabatic process, isothermal processes, isobaric and isochoric processes, throttling processes. Differential form of the first law, internal energy and heat capacity of an ideal gas , Adiabatic expansion of an ideal gas, applications of first law.

Heat Engines, internal combustion engines, steam Engines. The refrigerator, second law of thermodynamics, reversible and irreversible processes. Carnot's cycle. The Kelvin temperature Scale, absolute zero, devices that convert thermal energy to other forms of energy, entropy and its statistical interpretation.

Maxwell's thermodynamic relations and simple applications. Thermodynamic potentials and their applications. Phase transitions:Joule Kelvin effect, first order and countinuous transitions and Clausius-Clapeyron equation, applications of phase transitions to magnetism, superfluidity and super conductivity.

TEXTBOOKS/REFERENCES:
1. *Francis W. Sears, Mark W. Zemansky and Hugh D. Young*, University Physics(with edition), Pearson
2. *David Halliday, Robert Resnick, and Jearl Walker*, Fundamentals of Physics (8th Edition), John-Wiley (2008).
3. *M.W. Zemansky and R.H.Dittman*, Heat and Thermodynamics, McGraw Hill

4. Richard P.Feynmann, Robert.P.Leighton and Matthew Sands, Feynmann Lectures on Physics Vol. I, Narosa(2003)
5. Brij Lal, N.Subrahmanyam and P.S.Hemne, Heat, Thermodynamics and Statistical Physics (multicolour Edition) S.Chand &Co. New Delhi(2007)

PHY220 BASIC ELECTRONICS 3 1 0 4

Voltage and current-resistors, voltage dividers, voltage and current sources, Thevenin's theorem, sinusoidal signals, signal amplitudes and decibels, other signals, logic levels, signal sources -

Conduction in metals, semiconductors and insulators, intrinsic semiconductors, n and p materials, conduction by drift and diffusion, The p-n junction, Fermi level of pn junction, diode equation, Hall effect, diode characteristics, capacitance of a p-n junction, rectification, rectifier configurations for power supplies, circuit applications of a diode-as a switch, clipping, clamping, different types of diodes - Zener diodes, LEDs, diode lasers, photodiodes etc

Transistors - npn and pnp, transistor characteristics - CB, CE and CC configurations, relation between a, b and g, transistor switch, transistor biasing. Feedback circuits. Transistor action, emitter follower. Transistor applications as amplifier. RC coupled amplifier

Transistor as an oscillator, FET, JFET, MOSFET etc

Operational amplifiers: differential amplifier, inverting and non-inverting amplifiers ers. Op-amp applications-integrator, differentiator, adder etc. ICs - examples

Digital electronics: Digital versus analog, logic gates, truth table, discrete circuits for gates, logic identities, minimization and Karnaugh maps

TEXTBOOK:

Bernar Grob and Mitchel E.Schultz, Basic Electronics (IP Edition), Tata Mc Graw Hill, New Delhi (2003)

REFERENCES

1. John D. Ryder, Electronic Fundamentals and Applications, Prentice Hall of India Pvt. Ltd. New Delhi (1982)
2. Albert Paul Malvino, Digital Computer Electronics Tata McGraw Hill Pub Co. Ltd New Delhi (1980
3. Horowitz and Hill, The art of Electronics (Cambridge University press)

PHY221 WAVE MOTION AND OPTICS 3 1 0 4

Review of geometrical optics: Fermat's principle, Laws of reflection and refraction from Fermat's principle. Refraction at a spherical surface, Linear and lateral magnifications. Refraction through a thick lens. Focal lengths of thick and thin lenses. Combination of two lenses. Cardinal points.

Simple Harmonic motion (SHO), differential equation for SHO and its general solution, superposition of two or more SHOs. Lissajous figures. Damped and forced oscillators, resonance.

Wave equation, traveling and standing waves in one dimension, energy density and energy transmission in waves. Group velocity and phase velocity. Sound waves in media, Doppler effect.

Wave nature of light. Fresnel's equation and their consequences. Spatial and temporal coherence, interference of light, optical path retardation. Fresnel and Fraunhofer diffraction, diffraction grating, Rayleigh criterion and resolving power. Interferometers; optics of multi layer thin films: AR and HR coatings, ray matrix, optical instruments, Fourier optics.

Polarization: linear, circular, and elliptic polarization, double refraction and optical rotation. Propagation of light through matter, dispersion and absorption, nonlinear optic, second harmonic generation, integrated optics.

TEXTBOOKS/REFERENCES:

1. Optics - Hecht
2. Introduction to Modern optics by A.K. Ghatak (Tata McGraw Hill)
3. Introduction to Modern Optics - G.R. Fowls
4. Principles of Optics - M. Born and E. Wolf (Macmillan)
5. Richard P. Feynmann, Robert. P. Leighton and Matthew Sands, Feynmann Lectures on Physics Vol. I, Narosa (2003)
6. Optical Physics – S.C.Lipson and H.Lipson (Cambridge university press)

PHY252 PHYSICS OF SEMICONDUCTOR DEVICES 3 0 0 3

Crystal Structure: Crystal and non crystalline materials, Bravis lattices, crystal systems, symmetry elements, crystal structures, Miller indices, imperfections.

Electrical Conductivity: Classical Free electron theory of metals, expression for electrical conductivity, quantum free electron theory of metals, Fermi energy, origin of bad gap, effective mass.

Semiconductors: Elemental and Compound semiconductors, Intrinsic and extrinsic carrier concentration, variation of fermi level with carrier concentration and temperature, Hall effect.

Semiconducting Devices: Photo diodes, PIN diodes, frequency response silicon photo diodes, high speed long wavelength photo diodes.

Quantum Wells, heterojunction semiconductor devices, electro-optic modulators, electro absorption modulators, optical switching and logic ices.

Modern Semiconducting Devices: CCD – Introduction to nano devices, fundamentals of tunneling devices, design considerations, physics of tunneling devices.

TEXTBOOK:

S M Sze, "Physics of Semiconductor devices", Wiley Eastern, 1988.

REFERENCES:

1. *P Bhattacharya, "Semiconductor Opto-Electronic Devices", Prentice Hall, 1998 (II st edition)*
2. *J. Allison, "Electronic Engineering materials and Devices", Tata Mc Graw Hill, 1990*
3. *A J Decker, "Electrical Engineering Materials", PHI, New Delhi, 1957.*

PHY280	PHYSICS OF LASERS AND APPLICATIONS	3 0 0 3

Review of some basic concepts and principle of laser

Introduction to light and its properties: Reflection, Refraction, Interference, Diffraction and Polarization. Photometry – calculation of solid angle. Brewster's law. Snell's law and, its analysis.

Introduction to LASERS: Interaction of radiation with matter - Induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity.

Properties of LASERS

Gain mechanism, Threshold condition for PI (Derivation), Emission broadening-line width, derivation of De FWHM Natural emission line width as deduced by quantum mechanics- Additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadening in gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity

Properties – Coherency, Intensity, directionality, monochromaticity and Focusability.

LASER transition – Role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Types of LASERS

Solid State LASER: (i) Ruby LASER – Principle, Construction, working and application. (ii) Neodymium (Nd) LASERS. Gas LASER: (i) He-Ne LASER - Principle, Construction, working and application. (ii) CO_2 LASER - Principle, Construction, working and application.

Liquid Chemical and Dye LASERS. Semiconductor LASER: Principle, Characteristics, Semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semi conductor diode LASERS.

Applications in Communication field

LASER Communications: Principle, construction, types, modes of propagation, degradation of signal, Analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields

Holography: Principle, types, intensity distribution, applications. Laser induced fusion. Harmonic generation. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

REFERENCES:

1. *William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).*
2. *Bill Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.*
3. *Andrews, "An Introduction to Laser Spectroscopy (Del", Ane Books India (Distributors).*
4. *KR Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.*
5. *T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).*

PHY282	INTRODUCTION TO NON-LINEAR DYNAMICS	3 0 0 3

Introduction: examples of dynamical systems, driven damped pendulum, ball on oscillating floor, dripping faucet, chaotic electrical circuits.

One-dimensional maps: the logistic map, bifurcations in the logistic map, fixed points and their stability, other one-dimensional maps.

Non-chaotic multidimensional flows: the logistic differential equation, driven damped harmonic oscillator, Van der Pol equation, numerical solution of differential equations.

Dynamical systems theory: two-dimensional equilibrium and their stability, saddle points, are contraction and expansion, non-chaotic three-dimensional attractors, stability of two-dimensional maps, chaotic dissipative flows.

Lyapunov exponents: for one- and two-dimensional maps and flows, for three-dimensional flows, numerical calculation of largest Lyapunov exponent, Lyapunov exponent spectrum and general characteristics, Kaplan-Yorke dimension, numerical precautions.

Strange attractors: general properties, examples, search methods, probability of chaos and statistical properties of chaos, visualization methods, basins of attraction, structural stability.
Bifurcations: in one-dimensional maps and flows, Hopf bifurcations, homoclinic and heteroclinic bifurcations, crises.

Hamiltonian chaos: Hamilton's equations and properties of Hamiltonian systems, examples, three-dimensional conservative flows, symplectic maps.

Time-series properties: examples, conventional linear methods, a case study, time-delay embeddings.
Nonlinear prediction and noise-reduction: linear predictors, state-space prediction, noise reduction, Lyapunov exponents from experimental data, false nearest neighbors.

Fractals: Cantor sets, curves, trees, gaskets, sponges, landscapes.

Calculations of fractal dimension: similarity, capacity and correlation dimensions, entropy, BDS statistic, minimum mutual information, practical considerations.

Fractal measure and multifractals: convergence of the correlation dimension, multifractals, examples and numerical calculation of generalized dimensions.

Non-chaotic fractal sets: affine transformations, iterated functions systems, Mandelbrot and Julia sets.
Spatiotemporal chaos and complexity: examples, cellular automata, coupled map lattices, self-organized criticality.

TEXTBOOK:

Hilborn, R. C., Chaos and Nonlinear Dynamics, Second Edition, Oxford University Press, 2000

REFERENCES:

Sprott, J. C., Chaos and Time Series Analysis, Oxford University Press, 2003

Strogatz, S. H., Nonlinear Dynamics and Chaos, Westview Press, 2001

Solari, H. G., Natiello, M. A., and Mindlin, G. B., Nonlinear Dynamics, Overseas Press (India) Private Limited, 2008

PHY280	BASIC ELECTRONICS LAB.	0 0 3 1

Experiment List
1. Familiarization of devices and equipments
2. Diode Characteristics
3. Rectifiers – Half Wave, Full Wave and Bridge Rectifiers
4. Clipper and Clamper circuits
5. Zener Diode
6. Transistor Characteristics in Common Emitter mode
7. RC Coupled amplifier
8. Oscillators/Multi vibrators
9. Integrator/Differentiator
10. Adder/Subtractor
11. Operational Amplifiers
12. Introduction to Logic Gates

PHY281	PHYSICS LAB III	0 0 3 1

List of experiments
1. Field along the axis of a coil
2. Determine the Cauchy's constant using Spectrometer
3. Conversion of Galvanometer to Ammeter
4. Measurement of Laser beam divergence
5. Refractive index of transparent bar using diode Laser
6. Stefan – Boltzmann Constant determination.
7. Emissivity Measurement
8. Thermal conductivity of Solids.
9. Natural Convection heat transfer.
10. Moment of Inertia of Disc & Ring
11. Gyroscope couple determination.
12. Hartnell Governor - Speed vs sleeve displacement.

PHY321	INTRODUCTION TO ELECTRODYNAMICS	3 1 0 4

Laws of electrostatics and methods of solving boundary value problems, Multipole expansion of electrostatic potentials, spherical harmonics. Electrostatics in material media, dielectrics, Biot-Savart law, magnetic field and the vector potential. Faraday's law and time varying fields. Maxwell's equations, time varying em fields: Poynting vector, conservation laws, propagation of plane electromagnetic waves.

TEXTBOOK/REFERENCES

1. *Introduction to Electrodynamics - D.J. Griffiths, 3rd Edition, Pearson Education, Delhi, 1999*

2. Electromagnetic field theory fundamentals – Bhag S. Guru and HÜseyin R. Hiziroğlu, 2nd Edition, Cambridge University Press, 1st South Asian Edition, 2005
3. Classical Electrodynamics- J.D. Jackson, 3rd Edition, Wiley Eastern, New Delhi, 1999

PHY340 RELATIVITY AND MODERN PHYSICS 3 1 0 4

Inertial Frames and Galilean invariance. Postulates of special relativity. Lorentz transformations, length contraction, time dilation, relativistic velocity addition, simultaneity of events, mass- energy equivalence.

Blackbody radiation, photoelectric effect, Compton effect, Bohr's atom model, X-rays, origin of quantum mechanics and related experiments, wave particle duality, relation with measurement of dynamical variables. Delta function as definite position and plane wave as definite momentum wave function, wave packet as superposition of delta function and plane wave. Uncertainty principle, application of classical physics on the basis of uncertainty product, operator formulation, commutator operators. Schrodinger equation and its solution for one, two and three dimensional boxes, time evolution and stationary states, suare well potentials.

Practical examples like metal-vaccum interface, contact potential between metals, etc. Bound states in infinite and finite potential wells, Kronig-penny model for 1-D crystals. Reflection and transmission at a step potential, tunnelling through a barrier examples.

Eigenvalues and eigen functions. Harmonic Oscillator, Hydrogen atom, Pauli exclusion principle, distinguishable and indistinguishable particles, Phase space, Ensembles, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics-their applications.

Astrophysics - classification of stars, the sun, evolution of a star, white dwarves, neutron stars and black holes, galaxies and quasars.

TEXTBOOKS/REFERENCES:

1. Perspectives in modern physics - A. Beiser (McGraw Hill)
2. Modern Physics - K.Krane (John Wiley)
3. Richard P.Feynmann, Robert.P.Leighton and Matthew Sands, Feynmann Lectures on Physics Vol 1, Narosa (2003)
4. Elements of Modern Physics-S.H.Patil (TataMcGraw Hill)

PHY341 SOLID STATE PHYSICS AND DEVICES 3 1 0 4

Crystal structure, Bravais lattice and basis, unit cell, Miller indices, packing, interstitials and different ceramic structures; non-crystalline / nanocrystalline material definitions. Concept of Tg, local order, different polymer structures. Structure determination

using X-ray diffraction, point defects, edge and screw dislocations - their notations and concepts, Drude theory of metals, Einstein and Debye theory of specific heats. Free electron theory of metals, Fermi energy and density of states, origin of energy bands, Brillouine zones, concept of holes and effective mass.

Semiconductors, conductivity as a function of temperature, measurement of band gap, doping, Hall effect. Optical properties of semiconductors: direct and indirect band transitions, Augur transitions excitons, concept of lifetime. Applications of semiconductors as LEDs, Lasers, and solar cells, Introduction to semiconductor crystal growth and processing modern methods of epitaxy. (Brief introduction to quantum wells and super lattices if time permits)

Elementary ideas of para, dia, and ferromagnetisms, Curie's law, super conductivity, Meissner effect, tunneling in super conductors, Josephson junctions, squid, superconducting magnets. Einstein's relations, lifetime and collision broadening in atomic transitions, lasers and their general characteristics, resonant cavities and laser modes, Different types of lasers, their application.

TEXTBOOKS/REFERENCES:

1. C.Kittel Introduction to solid state physics (8 edition) (John Wiley) (2004)
2. N.W. Ashcroft and N.D.Mermin, Solid state Physics - Brooks Cole; 1 edition (1976)
3. S.Wang, Solid State Electronics - (McGraw Hill)

PHY342 ATOMIC, MOLECULAR AND NUCLEAR PHYSICS 3 1 0 4

Review of atomic structure of hydrogen, atomic structure of two electron system, alkali system, Hartee-Fock method, L-S and j-j coupling, molecular binding, LCAO, LCMO, molecular spectra: electronic, rotational and vibrational spectroscopy. Raman effect and Raman spectroscopy, ESR spectroscopy, modern spectroscopic techniques and instruments.

Structure and properties of atomic nucleus, mass and binding energy, nuclear force and nuclear models: liquid drop model and shell model, quadrupole moment, radioactivity and its applications, Law of radioactive decay, elements of nuclear reactors, Fission and Fusion, modern experimental tools of pure and applied nuclear physics, NMR spectroscopy, fundamental forces, elementary particles, quarks and leptons.

TEXTBOOKS/REFERENCES:

1. Principles of Lasers and their Applications
2. Introduction to Atmospheric Science
3. Physics of Universe

4. Order and Chaos
5. Special & General Relativity
6. Statistical Mechanics
7. Condensed Matter Physics
8. Physics of Information Processing

PHY343 MATHEMATICAL ASPECTS OF MECHANICS 3 0 0 3

Basics: Art of estimation and approximations, the concept of scaling, dimensional analysis and the nature of functional relationship among physical quantities as imposed by their dimensions (units).

Second order differential equations, linear and non-linear, with initial conditions and applications to motion in one dimension: changes, rates, graphs of motions; mathematical statement of Newton's laws; mathematical models of some forces in nature – gravitational, electrostatic, frictional, spring forces and forces that occur in constrained motion; Inhomogeneous differential equations and applications to forced and damped periodic motions.

First integral invariant and integral of motion; concepts of kinetic energy, work, potential and potential energy, conservation of mechanical energy, and power; phase-space description of motion: phase-space trajectories, flows, separatrices, and elementary stability theory.

Mathematics of motion of system of particles: center-of-mass coordinates and center-of-mass frame; models of contact forces, impulses and collisions; integral invariants and conservation of momentum.

Vector calculus and motion in 2 and 3 dimensions: trajectories in Cartesian, cylindrical and spherical polar coordinates; models of forces in 3 dimensions: vector fields - rotational, irrotational and conservative vector fields, Gauss divergence theorem and fields in a continuous distribution of matter, scalar fields and potentials; symmetry, cyclic coordinates and conservation laws; spherically symmetric force fields: inverse square and linear forces; integral invariants: energy, angular momentum, Laplace-Runge-Lenz vector.

Rotating coordinate systems and the rigid body motion: pure rotations, moment-of-inertia-tensor, combined translation and rotation, instantaneous axis of rotation, Chasles' theorem, Euler's equations.

Some mathematical aspects of the Special Theory of Relativity.

TEXTBOOKS:

1. Kleppner & Kolenkow, Introduction to Mechanics, Tata-McGraw-Hill India
2. Kittel, Berkeley Physics Series Vol I: Mechanics, 2nd Ed., Tata-McGraw-Hill India

REFERENCES

1. Phil Dyke & Roger Whitworth, Guide! Mechanics, Palgrave Mathematical Guides, Indian Reprint
2. David Morin (Harvard), Mechanics, CUP, 2007
3. Borisenko & Tarapov, Vector and Tensor Analysis with Applications, Dover Publications
4. Sokolnikoff & Redheffer, Mathematics of Physics and Modern Engineering, 2nd Ed., McGraw-Hill, Intl. Student Ed., 1966 (16th reprint in 1994)

PHY400 EXPERIMENTAL TECHNIQUES 4 0 0 4

Vacuum techniques: Production and measurement of vacuum, different types of vacuum systems and gauges. Electronics: Measurement techniques in electronics, uses of different measuring devices, Power supplies amplifiers, pulse techniques and high frequency techniques, Detectors: Study of different types of detectors, photographic detectors, microwave detectors, X ray detectors and nuclear radiation detectors.

Structure and multistructure analysis by X-rays and electron diffraction, transmission and scanning electron microscopy technique, Study of molecular structure by resonance techniques like NMR, FTNMR, and ESR, IR, FTIR, and Raman spectroscopies, Study of electronic structure by Photoelectron spectroscopy, and X ray absorption techniques. Study of surface morphology by structure by STM and AFM. Study of magnetic thin films by Ferromagnetic resonance, vibrating sample and torque magnetometry and magnetic force microscopy.

(If time permits the following may be included)
Work experience: Design and fabrication of simple pieces of equipments required in the Physics laboratory.

REFERENCES:

1. Spectroscopy (3 volumes): Herzberg
2. Spectroscopy – Banwell
3. Atomic and molecular Spectroscopy - G Aruldhas
4. Physical methods - R.S.Drago, Saunders college Publishing
5. Microanalysis of solids, B.G.Yacobi, D.B.Holt, Plenum press

PHY410 CLASSICAL MECHANICS 4 0 0 4

Newton's Laws – Newton's Laws, Free Fall, G-force – both qualitative & quantitative, Mechanics of a system of particles in vector form, Conservation of

linear momentum, energy and angular momentum. Degrees of freedom, Principle of virtual work, D'Alembert's principle including generalized coordinates and velocities, Lagrangian, action principle, external action, Euler-Lagrange equations; Constraints,

Applications of Lagrangian formalism; Generalized momenta, Hamiltonian, Hamilton's equations of motion, Phase space, Central forces & Kepler problem, bound and scattering motions, Scattering in a central potential, scattering cross section, Non-inertial frames of reference and pseudoforces - centrifugal, Coriolis and Euler forces, Elements of rigid-body dynamics, Euler angles - The symmetric top, Small oscillations, Normal mode analysis, Elementary ideas on general dynamical systems - conservative versus dissipative systems, Hamiltonian systems and Liouville's theorem, Canonical transformations, Poisson brackets, Action-angle variables

TEXTBOOKS/REFERENCES:

1. *"An Introduction to Mechanics"* - Kleppner and Kolenkow, McGraw-Hill, 2007
2. *"Lagrangian & Hamiltonian Mechanics"* - M. G. Calkin, Allied, 2000
3. *Classical dynamics of particles and Systems*, S. Marion & J. Thornton, Cengage Learning, 2003
4. *"Classical Mechanics"* – Goldstein, Poole & Safko, 3rd Ed., Addison Wesley, 2001

PHY429 ADVANCED ELECTRODYNAMICS 4 0 0 4

Review of Electrostatics: Gauss' Law and its applications; Laplace and Poisson equations, boundary value problems; Magnetostatics: Biot-Savart law,Ampere's theorem,

Electromagnetic induction; Maxwell's equations in free space and linear isotropic media; boundary conditions on fields at interfaces; Scalar and vector potentials; Gauge invariance;

Electromagnetic waves in free space, dielectrics, and conductors; Reflection and refraction, polarization, Fresnel's Law, interference, coherence, and diffraction; Dispersion relations in plasma; Lorentz invariance of Maxwell's equations;

Transmission lines and wave guides; Dynamics of charged particles in static and uniform electromagnetic fields; Radiation from moving charges, dipoles and retarded potentials.

TEXTBOOKS:

1. *Introduction to Electrodynamics* – Griffith
2. *Electrodynamics* – Jackson
3. *Electromagnetics* - Lavi
4. *Classical Electrodynamics* - Griener

PHY430 QUANTUM MECHANICS I 4 0 0 4

Wave-particle duality; Wave functions in coordinate and momentum representations; Commutators and Heisenberg's uncertainty principle; Matrix representation; Dirac's bra and ket notation; Schroedinger equation (time-dependent and time-independent); Eigenvalue problems such as particle-in-a-box, harmonic oscillator, etc.; Tunneling through a barrier; Motion in a central potential; Hydrogen atom, spin-orbit coupling, fine structure. Orbital angular momentum; Angular momentum algebra, spin; Addition of angular momenta;

REFERENCES

1. *Quantum Mechanics - Landau and Lifshitz, Butterworth*
2. *Modern quantum Mechanics - J.J. Sakurai, Pearson*
3. *Quantum Mechanics - E. Merzbacher, Wiley*
4. *Quantum Physics - S.Gasiorowicz, Wiley*
5. *Introduction to Quantum Mechanics - Griffith*
6. *Quantum Mechanics – Mathews & Venkatesham*

PHY431 QUANTUM MECHANICS II 4 0 0 4

Time independent perturbation theory, non-degenerate and degenerate cases. Fine and hyperfine structure of energy levels. Stark and Zeeman effects

Time dependent perturbation theory and Fermi's Golden Rule; Selection rules; Semi-classical theory of radiation; Variational method; WKB approximation

Elementary theory of scattering, phase shifts, partial waves, Born approximation; Identical particles, Pauli's exclusion principle, spin-statistics connection;

Relativistic quantum mechanics: Klein Gordon and Dirac equations.

TEXTBOOKS/REFERENCES:

1. *Quantum Mechanics - Landau and Lifshitz, Butterworths*
2. *Advanced quantum Mechanics - J.J.Sakurai,Pearson*
3. *Quantum Mechanics - E. Merzbacher, Wiley*
4. *Quantum Mechanics - Griener*
5. *Quantum Mechanics – Thambipper*

PHY432 MATHEMATICAL PHYSICS 3 0 0 3

Introduction to theoretical foundations of classical and modern physics – includes calculus of vector fields, linear algebra – Finite and infinite dimensional linear spaces, Infinite dimensional spaces, Generalized functions and elementary tensor calculus, Infinite Series, Fourier series, ODEs, Special functions, Probability

TEXTBOOKS:

1. *Essential Mathematical methods for Physicists*, Weber & Arfken, Academic Press, 2005. Chapters 1,2,3,5,6,8,11,12,14, 17
2. *Mathematics for Physicists*, Dennery & Krzywicki, Dover, 1996. (Chapters 2,3,4)
3. *Special Functions by W.W. Bell*, Dover, 2004
4. *M. Boas, Mathematical Methods in Physical Sciences, 2nd Edition, Wiley International Edition, (1983)*
5. *Mathematical methods of Physics*, Mathews & Walker, 2004 (Chapters 1,3)

PHY433 ADVANCED MATHEMATICAL PHYSICS 4 0 0 4

Functions of a complex variable, Fourier & Laplace Transforms, PDEs, Green'sfunctions, Integral representations, Calculus of variations - Functionals, Lagrange multipliers, Group theory – Elements of group theory, Discrete groups with examples, Continuous groups (Lie groups) (rotation group in 2 and 3 dimensions, U(1) and SU(2)), Generators, Representations

TEXTBOOKS:

1. *Mathematical Physics*, E. Butkov, Academic Press, 1968
2. *Mathematics for Physicists*, Dennery & Krzywicki, Dover, 1996 (Supplemented as and when required)
3. *Essential Mathematical methods for Physicists*, Weber & Arfken, Academic Press, 2005

PHY450 FUNDAMENTALS OF PLASMA PHYSICS 3 0 0 3

(Pre-requisite: Good academic standing, PHY321 & PHY 420, and Instructor approval).

Spatial scale of an unmagnetized plasma – Debye Length, time scale – plasma period, gyroradius and gyrofrequency of magnetized plasma, single particle motion in prescribed fields – ExB , grad-B, Curvature, and polarization drifts, magnetic moment, adiabatic invariants of particle motion, magnetic mirror, two fluid description of plasmas, electrostatic and electromagnetic waves, Instabilities, one fluid and MHD equations, MHD waves, Alfven waves, Viasov description of collisionless plasmas, electrostatic waves & Landau damping, MHD discontinuities.

TEXTBOOKS:

1. *Francis F. Chen, Introduction to plasma physics and controlled fusion*, Springer, 2006
2. *Boyd, T.J.M., and Sanderson, J.J., The Physics of plasmas*, CUP, 2003
3. *Krall, N.A., Trivelpiece, A.W., Principles of plasma physics*, McGraw Hill, 1973
4. *Stix, T.H., Waves in plasmas*, Springer, 1992

PHY451 SPACE PHYSICS 3 0 0 3

Pre-requisite: Good academic standing, PHY 321, PHY 420, preferably PHY450 & Instructor Approval).

Brief history of solar-terrestrial physics – The variable Sun and the heliosphere, Earth's space environment and upper atmosphere; space plasma physics – single particle motion, plasma state, Fluid description, MHD & Kinetic theory, Applications; solar wind & Interplanetary Magnetic Field(IMF), Shocks and Instabilities in space; Solar Wind interactions with magnetized planets – Introduction, planetary magnetic fields, spherical harmonic expansions, geomagnetic field and its measurements, variations in Earth's field, SW-magnetosphere interaction, magnetospheric dynamics; Ionospheres, currents in space and Ionosphere, dynamics of neutral atmosphere.

TEXTBOOKS:

1. *Kivelson & Russell, Introduction to Space Physics*, CUP, 1995
2. *Kallenrode, M-B., Space Physics: An introduction to plasmas and particles in the Heliosphere and Magnetospheres*, Springer, 3e, 2004
3. *Moldwin, M., An Introduction to Space Weather*, CUP, 2008
4. *Baumjohann, W., & Treumann, R.A., Basic Space Plasma Physics*, Imperial College Press, 1997
5. *Other excellent supplementary texts on space plasmas and introductory books on neutral atmosphere.*

PHY452 NONLINEAR DYNAMICS 3 0 0 3

(Pre-requisite: PHY262)

Typical examples of nonlinearities in vibration and wave phenomena; phase space, dissipative versus conservative systems, attractors, basins of attraction, elementary bifurcation theory, linear stability theory, Poincare sections and maps, strange attractors, Hamiltonian Chaos, Time series properties, Lyapunov exponents, transition scenarios (Feigenbaum, Ruelle-Takens, and intermittency), universality, synchronization, fractals, fractal dimensions, and analysis of time series by embedding.

Applications of nonlinear dynamics to different disciplines: ecology, engineering, neurobiology, and fluid dynamics.

Propagation of nonlinear pulses and the nonlinear Schrödinger equation, the Korteweg-de Vries equation, solitons; nonlinear wave interactions; forced nonlinear waves; examples and applications.

TEXTBOOKS/REFERENCES:

1. *Nonlinear dynamics: Integrability, Chaos and Patterns*, M. Lakshmanan & S.Rajasekhar, Springer, 2003

2. Nonlinear dynamics and Chaos, Strogatz, S.H., Westview press,2001
3. Chaos and nonlinear dynamics, 3e, OUP,2000
4. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering by Steven H. Strogatz (ISBN 0738204536)
5. Drazin, P. G. Nonlinear systems. Cambridge, UK: Cambridge University Press, 1992. ISBN 0521404894

PHY483 OPTOELECTRONICS 3 0 0 3

Electronic and optical processes in semiconductors. p-n junction theory. Light emitting diodes. Laser diodes: structures, properties and operating principles. Photodetectors. Solar cells. Optoelectronic modulators and switching devices. Systems needs and new device challenges.

TEXTBOOKS/REFERENCES:

1. Semiconductor Optoelectronic Devices, by P. Bhattacharya (2nd Edition, Prentice Hall, Upper Saddle River, 1997)
2. Physics of Semiconductor Devices, by S.M. Sze (2nd Edition, Wiley, New York, 1981)
3. Introduction to Solid State Physics, by C. Kittel (7th Edition, Wiley, New York, 1996)
4. "Optoelectronics: An introduction to materials and devices", J. Singh, McGraw-Hill
5. Optional supplement: "Optical Processes in Semiconductor", J. I. Pankove, Dover, 1975.

PHY484 INTRODUCTION TO NANOPHYSICS AND APPLICATIONS 3 0 0 3

Introduction: the relation of Physics to other Sciences - Introduction – Chemistry – Biology – Astronomy – Geology – Psychology – How did it get the way?

Basic properties and measuring methods of nanoparticles: Size effect and properties of Nanoparticles - Particle size - Particle shape - Particle density - Melting point, surface tension, wettability - Specific surface area and pore - Composite structure - Crystal structure - Surface characteristics - Mechanical property - Electrical properties - Magnetic properties - Optical property of nanoparticle.

Synthesize and Characterization: Classification of fabrication methods - top to bottom approach - bottom to top approach - physical and chemical methods - CVD, Controlled precipitation, solgel method PLD, etc. X-ray diffraction – Introduction – basic principles – characterization by XRD – examples of XRD characterization – Debye Scherer formula – FTIR – Introduction – basic principles – methodologies and accessories – interferences and artifacts. Scanning electron microscopy – basics and primary modes of operation – applications – Transmission electron microscopy - basic principles – Scanning tunneling microscopy – basic principles

and instrumentation – common modes of analysis and examples – sample requirements – artifacts – Atomic force microscopy – Introduction – basic principle – modes of operation – applications. Photoluminescence – basic principles – Spectroscopic Ellipsometry – Basic principles – Applications – Raman Spectroscopy — basic principles.

Unit IV Applications: Carbon nano structures – Carbon molecules, Carbon clusters - fullerene, CNTs and their applications, MEMs, NEMs and devices, Single Electron Transistors, Quantum Cascade Lasers, Smart materials.

REFERENCES:

1. Charles P Poole Jr. and Frank J Owens, Introduction to nanotechnology: Wiley 2003
2. W.R Fahner (Ed.), Nanotechnology and Nanoelectronics, Springer; 2006
3. M. Hosokawa, et al, Nanoparticle Technology Handbook, Elsevier Publishers (2007).

PHY481 & PHY482 PHYSICS LAB A & B 0 0 3 1 / 0 0 3 1

Michelson's interferometer, Millikan's oil drop experiment, Photoelectric effect, Anderson bridge, compressibility of liquid (ultrasonic), Cornus Fringes, Newton's law of cooling, Susceptibility by Gouy's method, Faraday effect - Verdect constant, Hall effect, Hysteresis of wire and rod, photo electric effect, bending loss in an optical fiber, emission spectra, absorption spectra of Iodine and KMnO4, thin film deposition, GM Counter, ABBE's Refractometer, some superconductivity experiments...etc

TEXTBOOKS:

1. Advanced Practical Physics – Worsnop & Flint
2. Laser Experiments –Singh

PHY498/PHY582 SEMINAR I / SEMINAR II 0 0 2 1 / 0 0 2 1

The aim of seminar course is to train students give technical presentations. The topics for presentation are chosen by the teacher and these may include the topics in the area of student's project work.

PHY499 MINI PROJECT 1 cr

The aim of the mini project work is to give first exposure to the student for research methodology. This can include literature survey, review, data collection and theoretical/experimental work on small parts of research in area chosen by the faculty guiding the mini project work.

PHY510 STATISTICAL MECHANICS 4 0 0 4

Systems with a very large number of degrees of freedom: the need for statistical mechanics, micro- and macrostates; Phase space, Liouville's theorem, ergodicity, fundamental postulates; probability theory; review of thermodynamics, thermodynamic potentials; microcanonical ensemble, connection with thermodynamics.

Canonical ensemble: partition function, free Energy and connection with thermodynamic quantities; classical ideal gas; Maxwell-Boltzmann distribution, equipartition theorem.

Quantum statistics: grand-canonical ensemble; ideal Fermi and Bose gases, photons and phonons; blackbody radiation, Planck's distribution law; Bose-Einstein condensation.

Phase transitions and critical phenomena: first- and second-order transition, order parameter; liquid-gas and para-ferromagnetic phase transitions, Ising model, critical exponents, universality; qualitative introduction to Renormalization groups.

Introduction to non-equilibrium processes: Brownian motion, diffusion, Fokker-Planck equation.

TEXTBOOKS/REFERENCES:

1. Silvio Salinas, *Introduction to Statistical Physics*, Springer Indian Reprint, 2000.
2. R.K. Pathria, *Statistical Mechanics*, 2nd Ed., Elsevier India, 2006.
3. F.Reif, *Fundamentals of Statistical and Thermal Physics*, MGH, 1978.
4. J.K. Bhattacharjee, *Statistical Mechanics: Equilibrium and Non-equilibrium Aspects*, Allied Publishers Pvt Ltd, 2001.
5. Kerson Huang, *Statistical Mechanics*, 2nd Ed., Wiley Indian Edition.

PHY520 ADVANCED ELECTRONICS 4 0 0 4

Optoelectronic devices, including solar cells, photodetectors, and LEDs; Digital techniques and applications (registers, counters, comparators and similar circuits); Introduction to operational amplifiers, Concept of negative feedback and virtual short, analysis of simple operational amplifier circuits, frequency response of amplifiers, Feedback topologies and analysis of discrete transistor amplifiers, Active filters and switched capacitor filters, Wave form generators, A/D and D/A converters, Basic concept of microprocessors, Architecture of 8085 A and its instruction set, programmable peripheral devices, Introduction to 8086 microprocessor and its instruction set and assembly level programming, Introduction to microcontrollers and embedded systems.

REFERENCES:

1. Malvino & Leach, *Digital principles and applications*, TMH, 2006
2. John D.Ryder, *Electronic Fundamentals and applications*, PHI, 1999
3. Gayakwad, *Operational Amplifiers & Linear Integrated Circuits*, Pearson India, 2001
4. Millman & Halkias, *Integrated Electronics*, TMH, 1991
5. Gaonkar, *Microprocessor Architecture Programming and Applications with the 8085*, Penram International, 1999

PHY540 NUCLEAR AND PARTICLE PHYSICS 4 0 0 4

Basic nuclear properties: size, shape, charge distribution, spin and parity; Binding energy, semi-empirical mass formula; Liquid drop model; Fission and fusion; Nature of the nuclear force, form of nucleon-nucleon potential; Charge-independence and charge-symmetry of nuclear forces; Isospin; Deuteron problem; Evidence of shell structure, single- particle shell model, its validity and limitations; Rotational spectra; Elementary ideas of alpha, beta and gamma decays and their selection rules; Interaction of radiation with matter, Fission and Fusion as energy sources; Nuclear reactions, reaction mechanisms, compound nuclei and direct reactions; Classification of fundamental forces; Elementary particles (quarks, baryons, mesons, leptons); Spin and parity assignments, Isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, parity non-conservation in weak interaction; Relativistic kinematics.

REFERENCES:

1. Preston and Bhaduri, *Structure of Nucleus*, Addison Wiley
2. D. Griffiths, *Introduction to Elementary Particles*, Wiley, 1987.
3. Krane, K.S., *Introductory Nuclear Physics*, Wiley.

PHY541 CONDENSED MATTER PHYSICS I 3 0 0 3

Overview of condensed matter: crystalline solids, liquids, liquid crystals, amorphous/glassy states, quantum liquids – superconductors, superfluids. Binding in solids: types of solids: molecular, covalent, ionic, and metallic; characteristic features and examples.

Crystalline solids: Bravais lattices; Diffraction of waves by crystals: structure factor; Bragg's law in direct and reciprocal lattice; Brillouin zones; Crystal systems: point groups, space groups; crystal symmetry and macroscopic physical property tensors.

Free electron theory of metals: thermal and electrical conductivity, Hall effect, electronic specific heat; inadequacy of the theory.

Electrons in periodic potentials: Bloch wavefunctions, nearly free electron model, energy bands and gaps, Brillouin zones, Fermi surface; conductors, insulators, and semimetals, effective mass, concept of holes. Tight binding model: examples. Band structure calculations: an overview; energy spectrum of selected solids.

Electron transport: wavepackets in crystals, semiclassical dynamics in electric and magnetic fields; cyclotron resonance; Landau levels, de-Haas van Alfen oscillations; quantum adiabatic phase (optional topic): anomalous and quantum Hall-effects.

Semiconductors: energy band structure, intrinsic and extrinsic semiconductors, electrical conductivity, p-n junction, Schottky-barrier.

TEXTBOOKS/REFERENCES:

1. *N.W. Ashcroft and N.D. Mermin, Solid State Physics*, Cengage Learning, 2008.
2. *Ibach and Lüth, Solid State Physics, 3rd Ed., Springer India.*
3. *Michael Marder, Condensed Matter Physics, Wiley Interscience, 2000.*
4. *C. Kittel, Introduction to Solid State Physics, 7th Ed., Wiley India.*
5. *Chaikin and Lubensky: Condensed Matter Physics, Cambridge University Press, Indian Reprint, 2007.*

PHYS42	CONDENSED MATTER PHYSICS II	3 0 0 3

Elements of electron-electron interaction: Hartree-Fock equations, correlation, screening; introduction to Fermi liquid theory.

Lattice vibrations: monoatomic and diatomic lattices, elastic and optical phonons, Debye theory of lattice specific heat; thermal conductivity: Umklapp processes, neutron scattering. Phonons in metals: electron-phonon interaction, effective electron-electron interaction.

Dielectrics: Macroscopic electrostatic Maxwell's equations, local field, screening, Clausius-Mossotti equation, polarization and adiabatic phase, optical properties of ionic crystals, polarons.

Magnetism in solids: para-, dia-, ferro- and anti-ferro magnetism, mechanisms, spin waves, colossal magnetoresistance, overview of spin transport and spin electronics.

Super conductivity: Meissner effect, London's equations, BCS theory, Ginzburg-Landau theory, flux quantization, Josephson effect, application: SQUID.

Introduction to physics of materials at nanoscale: size-dependent optical and electrical properties, overview of selected nanomaterials and nanodevices.

REFERENCES:

1. *N.W. Ashcroft and N.D. Mermin, Solid State Physics*, Cengage Learning, 2008.
2. *Ibach and Lüth, Solid State Physics, 3rd Ed., Springer India, 2004.*
3. *M. Marder, Condensed Matter Physics, Wiley Interscience, 2000.*
4. *C. Kittel, Introduction to Solid State Physics, 7th Ed., Wiley India.*
5. *De Ventra, et al, Introduction to Nanoscale Science and Technology, Springer India, 2004.*

PHYS81	ELECTRONICS LAB.	0 0 3 1

Design and study of CE amplifier with and without feedback, two stage amplifier, Power amplifier, Differential amplifier, Voltage regulated power supplies with Zener diodes and transistors, Design of basic OL, TI and TTL logic gates, R-S and J-K flip flops using NOR-NAND gates, Schmitt trigger using op-amp, Uses of IC 741, Phase shift oscillator, 555 timer, three terminal IC voltage regulator, Familiarization of 8085 kit and programming, A/D and D/A coverters, control of stepper motor.

TEXTBOOK/REFERENCE:

Paul B.Zbar & Allen P Malvino, Basics electronics - A text - Lab Manual.

PHYS96	MINI PROJECT	1 cr

The aim of the mini project work is to give first exposure to the student for research methodology. This can include literature survey, data collection, t theoretical/experimental work on small parts of research in area chosen by the faculty guiding the project work.

PHYS99	PROJECT	11 cr

The aim of the project work is to give more detailed exposure to the student for research methodology. This can include literature survery, data collection, theoretical/experimental work on significant parts of research in area chosen by the faculty guiding the project work. If the project to be carried out at other institutions/laboratories, the experts from these intutions are to be associated in choosing the research topic and its execution.

STA200	PROBABILITY AND STATISTICS	3 1 0 4

Unit 1: Probability Concepts: Random Experiment, Sample Space, Events, Probability Axioms, Elementary Theorems, Conditional Probability and Bayes' Theorem.

Unit 2: Random Variables, Discrete and Continuous Distributions- Uniform, Binomial, Poisson, Exponential, Gamma and Normal Distributions. Function of Random variables. Mathematical Expectations, Variance, Moments, Moment generating functions – Characteristic function (definition only). Chebychev's Inequality

Unit 3: Jointly Distributed Random Variables: Joint, Marginal and Conditional Probability Distributions, Transformation of Random Variables. Sequences of random variables, law of Large numbers, Central Limit Theorem. Sampling Distributions of Sample Mean, and Sample Variance. Student's T and F Distributions.

Unit 4: Theory of Estimation, Point and Interval Estimation Methods, Testing of Hypothesis, Large and Small Sample Tests for Mean, Variance and Proportion, Goodness of Fit, Testing of Independence and Homogeneity. Correlation and Regression: Scatter diagram, Principle of least squares, curve fitting, regression lines and coefficient of correlation, Rank correlation.

TEXTBOOKS:

1. *R.V.Hogg and E.A.Tanis, Probability and Statistical Inference, 8th edition, Pearson.*
2. *Sheldon M Ross, Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Academic Press.*
3. *P.L. Meyer, Introductory Probability and statistical Applications, Oxford & IBH Publishing Ltd.*

STA430 PROBABILITY THEORY 3 0 0 3

Axioms of Probability, Conditional Prob-ability and Independence, Random variables and distribution functions, Random vectors and joint distributions, Functions of random vectors.
Expectation, moment generating functions and characteristic functions, Conditional expectation and distribution.
Modes of convergence, Weak and strong laws of large numbers, Central limit theorem.

TEXTBOOK/REFERENCES:

1. *P. Billingsley, Probability and Measure, II Edition, John Wiley & Sons (SEA) Pvt. Ltd., 1995.*
2. *P.G. Hoel, S.C. Port and C.J. Stone, Introduction to Probability, Universal Book Stall, New Delhi, 1998.*
3. *V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Limited, 1988.*
4. *J.S. Rosenthal, A First Look at Rigorous Probability Theory, World Scientific, 2000.*
5. *M. Woodroofe, Probability with Applications, McGraw-Hill Kogakusha Ltd., Tokyo, 1975.*

STA431 STOCHASTIC PROCESSES 3 0 0 3

Definition and classification of general stochastic processes, Examples, Markov chains, Transition probability matrices, classification of states, recurrence, examples, Basic Limit theorems of Markov chains, Renewal Equation(Discrete case), Absorption probabilities, random walk and queueing examples, Continuous time markov chains, pure birth processes, poisson processes, birth and death processes, differential equation of birth and death processes, examples. Renewal processes, renewal equations and elementary renewal theorem, Brownian motion, continuity of paths and the maximum variables, variations and extensions.

TEXTBOOK/REFERENCES:

1. *Samuel Karlin & Howard M Taylor, A First course in Stochastic processes, Academic press, 1975.*
2. *Samuel Karlin & Howard M Taylor, A Second course in Stochastic processes, Acadiac press, 1981.*
3. *Sheldon M. Ross, Stochastic Processes, 2nd Edition John Wiley and Sons, Inc 2004*
4. *N.U.Prabhu, Stochastic Processes, Macmillan, NewYork*
5. *William Feller, An Introduction to Probability Theory and its Applications, Vol.I, Wiley Eastern Limited, New Delhi, 1968.*

STA432 STATISTICAL INFERENCES 3 0 0 3

A brief review of probability, random variables, mathematical expectation and special probability distributions, Sampling distributions, and order statistics.
Decision theory - The theory of games, statistical games, decision criteria, the minimax criterion and the base criterion.
Estimation theory - Unbiased estimators, efficiency, consistency, sufficiency, robustness, the method of moments, the method of maximum likelihood and Bayesian estimation and estimation applications.
Hypothesis testing - Testing a statistical hypothesis, loses and risks, the Neyman-Pearson lemma, the power function of a test, likelihood ration tests and applications.
Regression and correlation - Linear regression, method of least squares, normal regression and correlation analysis and multiple linear regression.
The general linear hypothesis, the regression model, one way and two way analysis of variance.
Non parametric tests- the sign tests, signed rank test, the U-test, the h-test tests based on rank.

TEXTBOOK/REFERENCES:

1. *Irwin Miller and Marylees Miller, Mathematical Statistics, 6th edition, pearson education, Asia, 1999*

2. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Limited, 1988
3. R.V.Hogg and E. A. Tanis, Probability and Statistical Inference, 8th edition, Pearson Education.

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