Gangadhar Meher University,

SAMBALPUR, ODISHA

UNDERGRADUATE PROGRAMME IN PHYSICS
(Courses effective from Academic Year 2017-18)

SYLLABUS OF COURSES OFFERED IN
Core Courses, Generic Elective, Ability Enhancement Compulsory Courses & Skill Enhancement Course

DEPARTMENT OF PHYSICS

Gangadhar Meher University
SAMBALPUR, ODISHA

REGULATIONS OF GENERAL ACADEMIC AND EXAMINATION MATTERS FOR BA/B.Sc./B.COM/BBA/BSc.IST EXAMINATIONS

(THREE YEAR DEGREE COURSE) UNDER CHOICE BASED CREDIT SYSTEM AND SEMESTER SYSTEM

(Effective for the students admitted to First year of Degree course during 2015-16 and afterwards)

CHAPTER-I

(REGULATIONS OF GENERAL ACADEMIC MATTERS)

1. APPLICATION & COMMENCEMENT:

(i) These regulations shall come into force with effect from the academic session 2015-16.

2. CHOICE-BASED CREDIT SYSTEM (CBCS):

CBCS is a flexible system of learning that permits students to

1. Learn at their own pace.
2. Choose electives from a wide range of elective courses offered by the University Departments.
3. Adopt an inter-disciplinary approach in learning and
4. Make best use of the expertise of available faculty.

3. SEMESTER:

Depending upon its duration, each academic year will be divided into two semesters of 6 months duration. Semesters will be known as either odd semester or even semester. The semester from July to December will be Semesters I, III, V and similarly the Semester from January to June will be Semesters II, IV & VI. A semester shall have minimum of 90 instructional days excluding examination days / Sundays / holidays etc.

4. COURSE:

A Course is a set of instructions pertaining to a pre-determined contents (syllabus), delivery mechanism and learning objectives. Every course offered will have three components associated with the teaching-learning process of the course, namely:

(i) Lecture – symbolized as L;

(ii) Tutorial – symbolized as T; and

(iii) Practical – symbolized as P.

In G.M. University, UG programmes have a minimum of 21 courses.

5. CREDIT:

Each course is rated in terms of credits or credit hours. Credit is a kind of weightage given to the contact hours to teach the prescribed syllabus, which is in a modular form. Normally one credit is allocated to 10 contact hours.

Mechanics of credit calculation:

As per G.M. University standard, 1 credit = 10 hours of lectures / contact hours. The contact hours will include all the modes of teaching like lectures / tutorials / laboratory work / field work or other forms. In determining the number of hours of instruction required for a course involving laboratory / field work, 2 hours of laboratory / field work is generally considered equivalent to 1 hour of lecture. In these regulations one credit means one hour of teaching works or two hours of practical works per week.

6. GRADE LETTER:

The Grade letter is an index to indicate the performance of a student in a particular course / paper. It is the transformation of actual marks secured by a student in a course / paper. The Grade letters are O, A+, A, B+, B, C, P, F. There is a range of marks for each grade letter.

7. GRADE POINT:

Grade point is an integer indicating the numerical equivalent of the letter grade / the weightage allotted to each grade letter depending on range of marks awarded in a course / paper.

8. CREDIT POINT (P):

Credit point is the value obtained by multiplying in grade point (G) by the credit (C): P = G x C.

9. SEMESTER GRADE POINT AVERAGE (SGPA):

SGPA is the value obtained by dividing the sum of credit points (P) earned by a student in various courses taken in a semester by the total number of credits earned by the student in that semester. SGPA shall be rounded off to two decimal places.

10. CUMULATIVE GRADE POINT AVERAGE (CGPA):

CGPA is the value obtained by dividing the sum of credit points in all the courses earned by a student for the entire programme, by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicates the comprehensive academic performance of a student in a programme.

An overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his / her CGPA.

11. COURSE STRUCTURE:

(a) COURSE: A course is a component / a paper of a programme. A course may be designed to involve lectures / tutorials / laboratory work / seminar / project work / practical training / report writing / viva voce etc. or a combination of these, to meet effectively the teaching and learning needs and the credits may be assigned suitably.

(b) TYPES OF COURSES:

(i) Core Courses (14x6=84 credits)

Core courses comprise a set of at least fourteen papers that are identified as compulsory for the students registered for the UG degree in a particular subject. Core courses shall be spread over all the semesters.

(ii) Ability Enhancement Compulsory Course (04 credits)

The Ability Enhancement Course (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement; i. Environmental Science and ii. English / MIL Communication. These are mandatory for all disciplines.

(iii) Skill Enhancement Course (SEC) (04 credits)

SEC courses are value-based and / or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. These courses may be chosen from a pool of courses designed to provide value-based and / or skill-based knowledge.

(iv) Elective Courses: 48 credits (24+24)

Elective Course: A course that can be chosen from a number of options other than the core and compulsory courses is known as elective course. An elective may be "Generic Elective" focusing on those courses which add generic proficiency to the student. An elective may be "Discipline Centric" or may be chosen from the main discipline / subject of study called Discipline Specific Elective. Such elective may also include project work / dissertation. It is considered as a special course involving the application of knowledge in solving / analyzing / exploring a real life situation / difficult problem.

The Three year Degree course leading to the Bachelors Degree in Arts/Science/Commerce/BBA/BSc.IST shall be spread over a period of six semesters in three academic years with the following course structure.

Semester	Core Course (6 credits per paper)	Ability Enhancement Compulsory Course (2 credits per paper)	Skill Enhancement Course (2 credits per paper)	Discipline Specific Elective (6 credits per paper)	Generic Elective (6 credits per paper)
I (350 Marks)	CC-I CC-II	AECC-I	-	-	GE-I
II (350 Marks)	CC-III CC-IV	AECC-II	-	-	GE-II
III (450 Marks)	CC-V CC-VI CC-VII	-	SEC-I	-	GE-III
IV (450 Marks)	CC-VIII CC-IX CC-X	-	SEC-II	-	GE-IV
V (400 Marks)	CC-XI CC-XII	-	-	DSE-I DSE-II	-
VI (400 Marks)	CC-XIII CC-XIV	-	-	DSE-III DSE-IV	-

CHAPTER – II
(REGULATION ON EXAMINATION MATTERS)

1. The Examinations

1.1.(a) A candidate for the Bachelor's Degree in Arts/Science/Commerce/BBA/BSc.IST shall be required to pass each of the following examinations.

(i)	Semester-I	(ii)	Semester-II
(iii)	Semester-III	(iv)	Semester-IV
(v)	Semester-V	(vi)	Semester-VI

Each of the semester examination includes one Mid-Term and one End Term examination.

1.1.(b) Each student has to register himself / herself within schedule date to be eligible to appear the examination. Unless a student registers himself /herself by filling up examination forms and pays the requisite fees for Semester-I, he/she will not be eligible to sit for semester-II examination. Similarly, he/she will not be eligible to take the subsequent semesters unless he/she registers for the previous semester.

1.1.(c) A student has to clear all semester examinations within a maximum period of 05 years.

1.2 Examination Calendar

The broad format of the examination calendar for UG classes shall be as follows:

(a)	Mid term examination of odd semesters	…	September
(b)	End Term examination of odd semesters	…	November – December
(c)	Mid term examination of even Semesters	…	February
(d)	End Term examination of even semesters	…	March – April

The detail programme of end term examination shall be notified one month before the commencement of examinations.

1.3. Mid Term examination

In each semester there shall be one Mid Term examination of one hour / 60 minutes duration irrespective of marks in each paper having theory component. Out of the total marks of a paper, 20% of marks are earmarked for midterm examination.

1.4 End Term Examination

At the end of each semester, there shall be one examination of each paper called End Term examination. It shall cover 80% of the total marks of a paper. A student fulfilling the following conditions is eligible to appear the End Term examination.

i. A student shall pay the prescribed examination fees and fill up the prescribed form meant for the examination as per the notification issued by Examination Section (General). No form fill up is allowed before seven days of the commencement of the End-Term examination.

ii. The minimum number of lectures, practicals, seminars, which a student shall be required to attend before being eligible to take any Semester Examination shall not be less than 75% of the total number of lectures, practicals, seminars taken separately during the semester period.

iii. Provided that in exceptional cases the authority may condone the shortage of attendance to the extent of 15%.

iv. Provided further that the authority may condone the shortage of attendance to the extent of 10% over and above 15% in respect of students who represented the college or the state in any National / State Level: Camp, NCC, games or sports during the semester period under reference subject to prior approval and subsequent production of authenticated certificate of participation.

1.5.(a) Mode of Examination

The duration of examination shall be as follows:

Examination	Total marks	Duration
Theory paper	40 Marks	2 hours
	60/80 Marks	3 hours
Practical papers / Project Papers	25 Marks	3 hours
	50/100 marks	6 hours

1.5.(b) Mode of question papers

(i) All examinations except Viva-voce and Project work shall be conducted by means of written paper (Printed, written / typed in English). The papers in Modern Indian Languages shall be set and answered in the respective languages as mentioned in the syllabus.

(ii) Questions for a paper shall be set covering the total course of that paper either unit wise giving options from each unit unless specified otherwise in the syllabus.

1.5 (c) Results of examinations

The candidates shall have to appear and secure minimum pass grade in all the paper of a semester examination to be declared as pass. The following 10 – point grading system and corresponding letter grades be implemented in awarding grades and CGPA under CBCS system.

1.6 Award of Grade

The grade awarded to the student in any particular course / paper shall be based on his / her performance in all the tests conducted in a semester for that course / paper. The percentage of marks secured by the students in a particular course / paper shall be converted to a grade and grade point for that course / paper in the manner specified in the following table after conversion in to 100 marks.

% of Marks	Grade	Grade Letter	Grade Point
> = 90 – 100	Outstanding	O	10.0
> = 80 – < 90	Excellent	A+	9.0
> = 70 – < 80	Very good	A	8.0
> = 60 – < 70	Good	B+	7.0
> = 50 – < 60	Above average	B	6.0
> = 40 – < 50	Average	C	5.0
> = 30 – < 40	Pass	P	4.0
< 30	Fail	F	0.0
	Absent	S	0.0
	Malpractice	M	0.0

N.B.: Grade 'P' (30% of marks) shall be the pass grade for Theory and Grade 'C' (40% of marks) shall be the pass grade for Practical / Project work / Dissertation.

1.7 Result

1.7(a) In order to pass a course / paper, a candidate has to secure a minimum of Grade Point 4.0 in that course / paper with Grade 'P' (30% of marks) in Theory and Grade 'C' (40% of marks) in Practical / Project work / Dissertation failing which the candidate will be marked 'F' in that course / paper with the Grade Point of 0.0 (below 30 marks) irrespective of the marks secured in that course / paper.

A candidate obtaining Grade 'F' shall be considered as fail and will be required to reappear the course(s) / paper(s) as back paper. The back paper examination shall be held with the normal end semester examination and the students with backlogs shall clear their backlog course(s) / paper(s) along with regular students of lower semesters in the subsequent year within a period of 05 years from the date of admission and with the current syllabus after two consecutive chances.

1.7(b) In order to clear a semester examination, a candidate is required to pass each credit course / paper of that semester and must secure a minimum Semester Grade Point Average (SGPA) of 4.0. The semester result shall be indicated as detail below:-

A. P (Passed or Cleared) indicating that:

- The candidate has cleared every registered course / paper of odd/even semester of the academic year with a minimum Grade Point (GP) of 4.0 in each paper / component of a paper.

  He / She has secured SGPA / CGPA of 4.0 or more.

B. NC (Not Cleared) indicating that:

The candidate is eligible for promotion with backlogs to next higher semester if he / she has registered for all the subjects of any semester.

C. 'X' (Not eligible for promotion) indicating that:

The candidate is not eligible for promotion to next higher level, when as he / she has not registered / filled up the form for the different subjects of a semester.

Computation of SGPA and CGPA

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

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

SGPA (Si) = $\sum(C_i X G_i)/\sum C_i$

Where C_i is the number of credits of i th course and G_i is the grade point scored by the student in the i th course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

CGPA = $\sum(C_i x S_i)/\sum C_i$

Where S_i is the SGPA of the Ist. semester and C_i the total number of credits in that semester.

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

Illustration of Computation of SGPA and CGPA and Format for Transcripts

i. Computation of SGPA and CGPA

Illustration for SGPA

Course	Credit	Grade letter	Grade point	Credit point
Course 1	3	A	8	3X8=24
Course 2	4	B+	7	4X7=28
Course 3	3	B	6	3X6=18
Course 4	3	O	10	3X10=30
Course 5	3	C	5	3X5=15
Course 6	4	B	6	4X6 =24
	20			139

Thus, SGPA = 139/20=6.95

Illustration for CGPA					
Semester-I	Semester-II	Semester-III	Semester-IV	Semester-V	Semester-VI
Credit-20 SGPA:6.9	Credit-22 SGPA:7.8	Credit-25 SGPA:5.6	Credit-26 SGPA:6.0	Credit-26 SGPA:6.3	Credit-25 SGPA:8.0
Thus, CGPA= $\frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144}$					=6.73

1.7(c) In order to pass a programme, a candidate must secure a minimum CGPA of 4.5. A candidate securing CGPA of less than 4.5 shall be declared as fail.

The conversion of CGPA to percentage of marks = (CGPA – 0.5) x 10.

The conversion of CGPA into Grade Letter shall be made on the basis of percentage of marks in the manner specified in the following table.

CGPA / OGPA	Grade Letter	Grade	% of Marks after conversion	Classification of Honours
> = 9.5	O	Outstanding	> = 90	First Class Honours
> = 8.5 - < 9.5	A+	Excellent	> = 80 – < 90	
> = 7.5 - < 8.5	A	Very good	> = 70 – < 80	
> = 6.5 - < 7.5	B+	Good	> = 60 – < 70	
> = 5.5 - < 6.5	B	Above average	> = 50 – < 60	Second Class Honours
> = 5.0 - < 5.5	C	Average	> = 45 – < 50	
> =4.5 – < 5.0	P	Pass	> = 40 - < 45	Pass without Honours
Below 4.5	F	Fail	< 40	Fail

1.8 Promotion to the next semester

A student shall be promoted to the next higher semester when he/she has appeared and passed in all the courses of the previous semester examinations. However, a student failing to appear / pass semester examination in few or all papers due to some reasons may be admitted to the next semester, provided that such a student shall produce sufficient proof in favour of his/her reason for not being able to appear / pass in some or all papers of the semester examination and has taken readmission in the year. Such students shall be considered as absent / failed candidate and will required to appear the repeat / back paper examination in the next year.

1.9 Repeat / Back Paper Examination

A student who remains absent or failed to secure 30% of marks / SGPA of 4.0 in aggregate has to take the repeat examination. He/she shall repeat all the theory and practical papers of that semester within a period of 5 years from the date of first registration. However, a student who secures more than 30% of marks / SGPA of 4.0 in aggregate but failed in one / some papers, he/she has to take the Back paper examination in the failed papers only. If the student is unable to clear the back papers in the next two consecutive chances, he/she has to appear the repeat examination of all papers in the third and subsequent chances as per the current syllabus and the marks secured in the previous examinations shall stand cancelled.

During back paper examinations, the higher marks of the papers shall be retained at the time of computation of result. The student passing in all papers in terms of grade point but failing in grade point average, then he / she has to appear the back paper examinations in those papers in which he / she has secured less than the required average grade point to pass. Such students shall have to apply to the Head of the Department in plain paper before one week of the form fill up and also filling the form in due date of the ensuing semester examination by depositing the fees as prescribed by the university. The repeat / back paper examination shall be held with the normal end semester examination.

A student appearing in repeat / back paper examination shall not be awarded distinction even if he/she subsequently fulfils the conditions of distinction and will not be included in the merit list. The final result of the candidate will be determined after taking all the subject wise marks and hard case rule into consideration. Candidates taking repeat / improvement examinations shall not be considered for the merit list and it shall be reflected in the provisional certificate- cum mark sheet but not in the final Degree certificate.

1.10 Improvement Examination

After the publication of final result the student getting 2nd Class (Honours) or Pass without Honours may be allowed to improve his/her performance in the next two year immediately from the year of publication of result. He/she shall be allowed to improve in Honours paper only. However he / she has to fill up the form of all the Honours papers of odd semester (I/III/V) and even semester (II/IV/VI). In such case, the highest mark secured in each paper shall be considered for computation of the mark.

1.11 Discipline in the examination

1.11(a) The students are allowed to enter the examination hall half an hour before the commencement of examination. A student arriving in the examination hall / room fifteen minutes after the commencement of the examination shall not be ordinarily allowed to sit for the examination. No examinee shall be allowed to go out of the examination hall within one hour of the commencement of examination.

1.11(b) The students are allowed to enter the examination hall only with a valid admit card and Identity card. Mobile phones and any other electronic gadgets are strictly prohibited in the examination hall. The possession of such things in the examination hall shall be treated as malpractice.

1.11(c) The possession of unauthorized materials and using it / copying from the scripts of other students / from any other source, sharing his/her answer scripts with other, creating disturbance or acting in a manner, so as to create inconvenience for the other students / invigilators inside the examination hall shall be treated as adoption of unfair means or malpractice.

In case of adoption of unfair means by an examinee in the examination hall / outside, the invigilator shall immediately report to the Centre Superintendent in writing along with the incriminating material recovered from the examinee signed by both the examinee and invigilator. The Centre Superintendent shall refer the matter to the Controller of Examinations for necessary disciplinary action as per the rules and regulations of the University.

1.12 Issue of Grade sheet, Provisional Certificate, Award of Degree & Gold Medals.

After the publication of the result of Semester examination, the Controller of Examinations shall issue the grade sheet of each semester as per the prescribed format (Appendix-I) and provisional certificate cum grade sheet after the final semester examination as per the prescribed format (Appendix-II) to the candidates against a prescribed fee collected at the time admission / filling of form. A degree certificate under the official seal of the university and signed by Vice-Chancellor as per the prescribed format (Appendix-III) shall be issued / given to the successful students of a particular course at the convocation or in-absentia on submission of application and fee as prescribed.

For award of gold medals, the University shall form a committee. The best graduate shall be decided from amongst the toppers of each Honours. In case of equality of CGPA, the SGPA of last semester examination shall be considered. The students who have failed / remained absent / improved their marks by repetition or improvement shall not be eligible for University rank or gold medal.

Registrar
G.M. University, Sambalpur

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B. Sc. Honours in PHYSICS

Semester		CORE COURESE (14)	Ability Enhancement Compulsory Course (AECC)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CC1	Mathematical Physics-I	Environmental Studies			GE-I Mechanics
	CCII	Mechanics				
II	CCIII	Electricity and Magnetism	English Communication/ Odia/ Hindi			GE-II Electricity, Maggnetism and Electro Magnetic Theory
	CCIV	Waves and Optics				
III	CCV	Mathematical Physics-II		SEC -I Communicative English and Writing Skill		GE-III Thermal Physics and Statistical Mechanics
	CCVI	Thermal Physics				
	CCVII	Digital System And Application				
IV	CCVIII	Mathematical Physics-III		SEC -II Renewable Energy and Energy Harvesting		GE-IV Waves and Optics
	CCIX	Elements of Modern Physics				
	CCX	Analog System and Application				
V	CCXI	Quantum Mechanics and Application			DSE-I Classical Dynamics	
	CCXII	Solid State Physics			DSE-II Nuclear and Particle Physics	
VI	CCXIII	Electromagnetic Theory			DSE-III Computational Physics	
	CC XIV	Statistical Mechanics			DSE-IV Dissertation / Project	

Semester	Course Name	Course Offered	Title Of Paper	Credits	Marks
I **4 Papers** **(350 Marks)** **20 credits**	**AECC**	Ability Enhancement Compulsory Course-I	Environmental Studies	**2**	**50 (10+40)**
	Generic Elective	Generic Elective –I	Mechanics	4	**75 (15+60)**
		PHYSICS GE I Practical	Practical	2	**25**
	Core Course	Core course-I	Mathematical Physics-I	4	**75 (15+60)**
		Core Course-I Practical	Practical	2	**25**
		Core course-II	Mechanics	4	**75 (15+60)**
		Core Course-II Practical	Practical	2	**25**
II **4 Papers** **(350 Marks)** **20 credits**	**AECC**	Ability Enhancement Compulsory Course-II	English Communication/ Odia/ Hindi	**2**	**50 (10+40)**
	Generic Elective	Generic Elective –II	Electricity, Maggnetism and Electro Magnetic Theory	**4**	**75 (15+60)**
		Generic Elective –II	Practical	**2**	**25**
	Core Course	Core course-III	Electricity and Magnetism	**4**	**75 (15+60)**
		Core Course-III Practical	Practical	**2**	**25**
		Core course-IV	Waves and Optics	**4**	**75 (15+60)**
		Core Course-IV Practical	Practical	**2**	**25**
III **5 Papers** **(450 Marks)** **26 credits**	**SEC**	Skill Enhancement Course -I	Communicative English & Writing Skills	**2**	**50 (10+40)**
	Generic Elective	PHYSICS GEIII	Thermal Physics and Statistical Mechanics	**4**	**75 (15+60)**
		PHYSICS GEIII Practical	Practical	**2**	**25**
	Core Course	Core course-V	Mathematical Physics	**4**	**75 (15+60)**
		Core Course-V Practical	Practical	**2**	**25**
		Core course-VI	Thermal Physics	**4**	**75 (15+60)**
		Core Course-VI Practical	Practical	**2**	**25**
		Core course-VII	Digital System And Application	**4**	**75 (15+60)**
		Core Course-VII Practical	Practical	**2**	**25**
IV **5 Papers** **(450 Marks)** **26 credits**	**SEC**	Skill Enhancement Course -II	Renewable Energy and Energy Harvesting	**2**	**50 (10+40)**
	Generic Elective	Generic Elective – IV	Waves and Optics	**4**	**75 (15+60)**
		Generic Elective – IV Practical	Practical	**2**	**25**
	Core Course	Core course-VIII	Mathematical Physics-III	**4**	**75 (15+60)**
		Core Course-VII Practical	Practical	**2**	**25**
		Core course-IX	Elements of Modern Physics	**4**	**75 (15+60)**
		Core Course-IX Practical	Practical	**2**	**25**
		Core course-X	Analog System and Application	**4**	**75 (15+60)**
		Core Course-X Practical	Practical	**2**	**25**
V **4 Papers** **(400 Marks)** **24 credits**	**DSE**	Discipline Specific Elective –I	Classical Dynamics	4	**75 (15+60)**
		Discipline Specific Elective -I Practical	Practical	2	**25**
		Discipline Specific Elective –II	Nuclear and Particle Physics	4	**75 (15+60)**
		Discipline Specific Elective- II Practical	Practical	2	**25**
	Core Course	Core course-XI	Quantum Mechanics and Application	4	**75 (15+60)**
		Core Course-XI Practical	Practical	2	**25**
		Core course-XII	Solid State Physics	**4**	**75 (15+60)**
		Core Course-XII Practical	Practical	2	**25**

Semester	Course Name	Course Offered	Title Of Paper	Credits	Marks
VI **4 Papers** **(400 Marks)** **24 credits**	**DSE**	Discipline Specific Elective – III	Computational Physics	4	**75 (15+60)**
		Discipline Specific Elective –III Practical	Practical	2	**25**
		Discipline Specific Elective-IV	Dissertation/ Project Work	6	**100**
	Core Course	Core course-XIII	Electromagnetic Theory	4	**75 (15+60)**
		Core Course-XIII Practical	Practical	2	**25**
		Core course-XIV	Statistical Mechanics	4	**75 (15+60)**
		Core Course-XIV Practical	Practical	2	**25**
	Total Credits			**140**	**2400**

SEMESTER – I

Ability Enhancement Compulsory Course (AECC-I): Environment Studies

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

Unit I: Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit II : Natural Resources : Renewable and Non-renewable Resources

- Land resources and landuse change; Land degradation, soil erosion an desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit III: Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

Unit V: Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. *Global Ethics and Environment,* London, Routledge.
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10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
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18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

Physics GE I: Mechanics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Vectors: Vector algebra, Scalar and vector products, Derivatives of a vector with respect to a parameter.
Ordinary Differential Equations: 1st order homogeneous differential equations, 2nd order homogeneous differential equations with constant coefficients.

Laws of Motion: Frames of reference, Newton's Law of motion, Dynamics of a system of particles, centre of mass.

Unit II: Momentum and Energy: Conservation of momentum, Work and Energy, Conservation of energy, Motion of rockets.
Rotational Motion: Angular velocity and angular momentum. Torque, Conservation of angular momentum.

Gravitation: Newton's law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Law (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea about Global Positioning System(GPS). Weightlessness. Physiological effect of astronaut

Unit III: Oscillations: Simple Harmonic Motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total energy and their time averages. Damped oscillations.

Unit IV: Elasticity: Hook's Law—Stress- strain diagram- Elastic moduli- Relation between elastics constants- Poisson's ratio- Expression for Poisson's ratio in term of elastic constants- Work done in stretching and work done in twisting a wire- twisting couple on a cylinder- Determination of Rigidity modulus by static torsion—Torsional Pendulum- Determination of Rigidity modulus and moment of inertia-q,η and σ by Searle's method.

Unit V: Special Theory of Relativity: Constancy of speed of light. Postulate of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Note: *Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to radial coordinate*

Reference Books:

- University Physics. F.W. Sears, M.W. Zeemansky and H.D. Young, 13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics, Vol.1: Charles Kittel, et.al. 2007, Tata McGraw- Hill
- Physics – Resnick, Halliday & Walker, 9/e, 2010, Wiley
- University Physics, Ronald Lane Reese, 2003, Thomas Brooks/Cole
- Properties of Matter: D.S. Mathur (S.Chand Publication) 2013
- Mechanics – D.C. Tayal(Himalaya Publication) 2013
- Classical Dynamics of Particles and Systems- S.T. Thornton (Cengage Learning) 2012
- Analytical Mechanics- Fowles (Cengage Learning) 2014
- Classical Mechanics - M. Das, P.K. Jena, M. Bhuyan, and R. N. Mishra (Srikrishna Publication)

PHYSICS LAB: GE I LAB: MECHANICS
Full Marks – 25, Credits- 02

1. Measurement of length, (or diameter) using vernier caliper, screw guage and travelling microscope.
2. To determine the Height of a Building using Sextant.
3. To determine the Moment of Inertia of Flywheel.
4. To determine the Young modulus of a wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a wire by Maxwell's needle
6. To determine the Young modulus of a wire by Searle's Method.
7. To determine the 'g' by Bar Pendulum.
8. To determine the 'g' by Kater's Pendulum.
9. To study the motion of a Spring and calculate(a) Spring Constant, (b) 'g'.
10. To determine the Modulus of Rigidity by Static Method.
11. To determine the velocity of sound by resonance column method.
12. Verification of Laws of transverse vibration of string by Sonometer.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971 , Asia Publishing House.
- Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Hienemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Physics CC I: Mathematical Physics-I

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

The emphasis of course is on application in solving problems of interest to physicists.
The students are to be examined entirely on the basis of problems, seen and unseen.

Unit I: Calculus: Calculus of function of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor with simple illustration. Constraint Maximization using Lagrange Multipliers.

Dirac Delta function and its properties:
Definition of Dirac Delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Unit II: Orthogonal Curvilinear Coordinates:
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate systems. Comparison of velocity and acceleration in cylindrical and spherical coordinate system. Relation of rectangular coordinate with spherical and cylindrical coordinates.

Unit III: Vector Calculus:
Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. Scalar triple product & Vector triple product.

Unit IV: Vector Differentiation:
Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities Solenoidal, irrational vectors and their physical significance. Notion of infinitesimal line, surface and volume elements, Line, surface and volume integrals of vector fields

Unit V: Vector Integration:
Ordinary Integrals of Vectors, Multiple integrals, , Flux of a vector field, Gauss' divergence theorem, Green's and Strokes theorem and their applications.

Reference Books:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber,F.E.Harris,2013,7th Edn.,Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington,2009, PHI learning.
3. Differential Equations, George F. Simmons,2007, Mc Graw Hill.
4. Mathematical Tools for Physics, James Nearing,2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A Mc quarrie,2003,Viva Book.
6. Advanced Engineering Mathematics,D.G. Zill and W.S Wright,5Ed.,2012,Jones and Bartlett Learning.
7. Advanced Engineering Mathematics ,Erwin Kreyszig ,2008,Wiley India.
8. Essential Mathematical Methods, K.F. Riley & M.P. HOBSON,2011, Cambridge Univ. Press.
9. Mathematical Physics and Special Relativity—M. Dash, P.K. Jena and B.K.Dash(Srikrishna Prakashan) 2nd Edition 2009.
10. Mathematical Physics-H.K.Dass, Dr.Rama Verma (S.Chand Higher Academics) 6th Edition 2011.
11. Mathematical Physics-C.Harper, (Prentice Hall India) 2006.
12. Mathematical Physics-Goswami (Cengage Learning) 2014
13. Mathematical Method for Physical Sciences-M.L.Boas(Wiley India)2006

PHYSICS LAB-C I LAB: MATHEMATICAL PHYSICS-I

Full Marks – 25, Credits- 02

The aim of this lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve the physical problems.
- The course will consist of lecturers (both theory and practical) in the lab.
- Evaluation done not on the programming but on the basis of formulating the problem.
- Aim at teaching students to construct the computational problem to be solved.
- Students can use any one operating system Linux or Microsoft Windows.

Topics	Description with Applications
Introduction and Overview	Computer architecture and organization, memory and Input/output devices.
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, Constants, Variables and data types, operators and expressions, I/O/ Statements, scanf & printf, c in and c out , manipulators for data formatting, control statements (decision making and looping statements) (If—statement, If—else statement. Nested if Structure, Else – if Statement, Ternary Operator.Goto Statement, Switch Statement, Unconditional and Conditional Looping, While Loop, Do-While Loop, For Loop, Break and Continue statements, Nested Loops), Arrays (1D & 2D) and strings, user defined functions, structures and unions, Idea of classes and objects
Programs:	Sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending and descending order, Binary search
Random number generation	Area of a circle, area of square, volume of sphere, value of π

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw—Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing. W.H. Pressetal, 3rd Edn. 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M.Ascher & C.Greif,2012,PHI Learning.
- Elementary Numerical Analysis,K.E.Atkinson, 3rd Edn.,2007,Wiley India Edition.
- Numerical Methods for Scientists &Engineers,R.W.Hamming,1973,Courier Dover Pub.
- An Introduction to Computational Physics ,T.Pang,2nd Edn.,2006,Cambridge Univ. Press.

Physics CC II: Mechanics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Rotational Dynamics: Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia for a rectangular body, Cylinder, Spherical Shell, Solid Sphere. Kinetic energy of rotation. Motion involving both translation and rotation.

Unit II: Non-Inertial Systems: Non-Inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its application.

Elasticity: Elastic constants and Hook's Law. Relation between Elastic constants.Twistng torque on Cylinder or wire.

Viscosity: Viscosity of liquids, Poiseullie's equation for flow of liquid through a capillary tube. Stoke's Law and its application for the determination of coefficient of viscosity.

Unit III: Gravitation and Central Force Motion: Law of Gravitation. Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field, Two body problem and its solution. The energy equation and energy diagram. Keplar's laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of Global Positioning System (GPS), Physiological effects on astronauts.

Unit IV: Oscillations: SHM: Simple Harmonic Oscillations, Differential equation of SHM and its solution. Kinetic energy, Potential Energy, total energy equation and their time-average values. Damped oscillation. Forced oscillations, Transient and steady states. Resonance, Sharpness of resonance, Power dissipation and Quality factor.

Unit V: Special Theory of Relativity: Michelson-Morley experiment and its outcome. Postulates of Special theory of Relativity. Lorentz Transformations, Simultaneity and order of events, Lorentz Contraction, Time Dialation, Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Mass energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics, Transformation of Energy and Momentum.

Reference Books:

- An introduction to Mechanics. D.Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkley Physics, vol.1, C. Kittel, W.Knight, et.al.2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday& Walker 8/e.2008, Wiley.
- Analytical Mechanics, G.R. Fowels and G.L. Cassiday.2005, Cengage Learning.
- Feynman Lectures, Vol.I, R.P. Feynman .B. Leignton, M.Sands, 2008, Pearsons Education.
- Introduction to Special Relativity, R.RESNICK, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics,D.S. Mathur,S.Chand and Company Limited,2000
- University Physics, F.W. Sears, M.W. Zeemansky, H.D. Young 13/e ,1986,Addison Wesley.
- Physics for scientists & Engineers with modern Phys.,J.W. Jewett,R.A. Serway, 2010, Cengage Learning.
- Theoretical Mechanics,M.R Spiegel,2006, McGraw Hill.
- Mechanics-J.C. Slater and N.H.Frank(McGraw-Hill)
- Classical Mechanics & General Properties of Matter: Maity & Ray Choudhury (New Age International Publishers)
- Classical Mechanics: Das, Jena, Bhuyan & Mishra (Sri Krishna Prahashan, Cuttack)
- Mechanics: B.S. Agrawal(Pragati Prakashan)
- Vibration, Waves & Accoustics: Chottapadhay & Rakshit(Books & Allied (P) Ltd.)
- Mechanics:P.K. Srivastava(New Age International Publishers)
- Mechanics:D.C. Tayal(Himalaya Publishing House)
- Classical Mechanics and General Properties of Matter: Maiti and Roy Choudhury(New Age Int.)
- Classical Mechanics:Das, Jena, Bhuyan and Mishra(Srikrishna Prakashan, Cuttack)

PHYSICS LAB-C II LAB: MECHANICS

Credits – 2 , Full Marks – 25, 60 Lectures

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a)Spring constant, (b) g and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine g and velocity for a freely falling body using digital timing technique.
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille'smethod)
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a wire by Maxwell's needle.
9. To determine the Young's Modulus of a wire by Searle's method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater's Pendulum.
12. To determine the Modulus of rigidity by dynamic method.
13. To determine the modulus by static method.

Reference Books

- Advanced Practical Physics for students, B.L.Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramkrishna, 11th Edn, 2011, Kitab Mahal.

SEMESTER-II

Ability Enhancement Compulsory Course (AECC II): ENGLISH

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)

(Unit wise question pattern, answer one question from each unit)

This course aims at enhancing the English language proficiency of undergraduate students in humanity, science and commerce streams to prepare them for the academic, social and professional expectations during and after the course. The course will help develop academic and social English competencies in speaking, listening, pronunciation, reading and writing, grammar and usage, vocabulary, syntax, and rhetorical patterns. Students, at the end of the course, should be able to use English appropriately and effectively for further studies or for work where English is used as the language of communication.

Unit I: Reading Comprehension

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas, and information
- Read "between the lines" to understand underlying meanings
- Connect information to what they already know

Book Prescribed

Vistas and Visions: An Anthology of Prose and Poetry. Texts to be studied

PROSE

- Playing the English Gentleman (M.K. Gandhi)
- The Need for Excellence (N.R. Narayana Murthy)
- The Last Leaf (O. Henry)

POETRY

- One Day I Wrote Her Name (Edmund Spenser)
- Miracles (Walt Whitman)
- The Felling of the Banyan Tree (DilipChitre)

Unit II: Writing

1. Expanding an Idea
2. Writing a Memo
3. Report Writing
4. Writing a Business Letter
5. Letters to the Editor
6. CV & Resume Writing
7. Covering Letter
8. Writing Formal Email
9. Elements of Story Writing
10. Note Making

Unit III: Language functions in listening and conversation

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually
   (Practice to be given using speaking activities from the prescribed textbooks)

Grammar and Usage

1. Simple and Compound Sentences
2. Complex Sentences
3. Noun Clause
4. Adjective Clause
5. Adverb Clause
6. The Conditionals in English
7. Words and their features
8. Phrasal Verbs
9. Collocation
10. Using Modals
11. Use of Passives
12. Use of Prepositions
13. Subject-verb Agreement
14. Sentence as a system
15. Common Errors in English Usage

Examination pattern

Each reading and writing question will invite a 200 word response.
Language function questions set in context will carry 01 mark per response. There will be 15 bit questions.
Midterm test 10 marks
End Term Total 40 marks
Unit I- Reading: 05 questions (03x 05 qns= 15 marks)
Unit II- Writing: 03 questions (05 x 03 qns= 15 marks)
Unit III- Grammar & usage: 10 qns (01x 10 qns = 10 marks)
Grammar questions must be set in contexts; not as isolated sentences as used for practice in the prescribed textbook.

All grammar and writing activities in the textbook

'Vistas and Visions: An Anthology of Prose and Poetry' (Ed.) Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. (Orient Black Swan Publisher)

Ability Enhancement Compulsory Course (AECC II) ODIA

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)

(Unit wise question pattern, answer one question from each unit)

ପ୍ରଥମ ଏକକ : କବିତା : ଭକ୍ତି - ଗଙ୍ଗାଧର ମେହେର

ଗ୍ରାମପଥ - ବିନୋଦ ଚନ୍ଦ୍ର ନାୟକ

ଦ୍ୱିତୀୟ ଏକକ : ଗଳ୍ପ : ମାଗୁଣିର ଶଗଡ - ଗୋଦାବରୀଶ ମହାପାତ୍ର

ଗୋପପୁର - ରାମଚନ୍ଦ୍ର ବେହେରା

ତୃତୀୟ ଏକକ : ପ୍ରବନ୍ଧ : ଜନ୍ମଭୂମି - କୃଷ୍ଣଚନ୍ଦ୍ର ପାଣିଗ୍ରାହୀ

ଆଧୁନିକ - ହରେକୃଷ୍ଣ ମହତାବ

ଚତୁର୍ଥ ଏକକ : ପ୍ରବନ୍ଧ ରଚନା, ପତ୍ରଲିଖନ, ସମ୍ବାଦଲିଖନ

ପଞ୍ଚମ ଏକକ : ବ୍ୟାକରଣ – ଭ୍ରମ ସଂଶୋଧନ, ବିପରିତାର୍ଥବୋଧକ ଶବ୍ଦ, ସମୋଚ୍ଚାରିତ ଭିନ୍ନାର୍ଥବୋଧକ ଶବ୍ଦ

ଆନ୍ତଃପରୀକ୍ଷା ପାଇଁ ୧୦ ମାର୍କ ପ୍ରଶ୍ନ ପଡିବ । (୧ x ୧୦ = ୧୦)

ବିଶ୍ୱବିଦ୍ୟାଳୟସ୍ତରୀୟ ମୁଖ୍ୟ ପରୀକ୍ଷାରେ ନିମ୍ନମତେ ପ୍ରଶ୍ନ ପଡିବ:

ପ୍ରଥମ ଏକକରୁ ଚତୁର୍ଥ ଏକକ ପର୍ଯ୍ୟନ୍ତ ପ୍ରତ୍ୟେକ ଏକକରୁ ୨ଟି ଲେଖାଏଁ ପ୍ରଶାନ ପଡିବ। ବିଦ୍ୟାର୍ଥୀ ପ୍ରତ୍ୟେକ ଏକକରୁ ଗୋଟିଏ ଲେଖାଏଁ ପ୍ରଶ୍ନ ର ଉତ୍ତର ଦେବେ । (୪ x ୮ = ୩୨)

ପଞ୍ଚମ ଏକକରୁ ୧୫ ଟି ଅତି ସଂକ୍ଷିପ୍ତ ପପ୍ରଶ୍ନ ପଡିବ । ବିଦ୍ୟାର୍ଥୀ ନିର୍ଦ୍ଦେଶ ଅନୁଯାୟୀ ୮ ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବେ । (୮x୧=୮)

ଗ୍ରନ୍ଥ ସୂଚୀ

୧. କବିତାଶ୍ରୀ - ସଂ. – କୃଷ୍ଣଚରଣ ବେହେରା

୨. ଗଳ୍ପ ଦିଗନ୍ତ - ସଂ. – ସୁରେନ୍ଦ୍ର ନାଥ ଦାସ

୩. ଭାଷଣ କଳା ଓ ଅନ୍ୟାନ୍ୟ ପ୍ରସଙ୍ଗ - ଡ. କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ

୪ . ପ୍ରବନ୍ଧ ଗୌରବ - ସଂ.- ପ୍ର. କୃଷ୍ଣଚାନ୍ଦ୍ର ପ୍ରଧାନ

୫. ସାରସ୍ୱତ ପ୍ରବନ୍ଧ ପତ୍ରମାଳା -

୬. ବିଶ୍ୱବିଦ୍ୟାଳୟ ପ୍ରବନ୍ଧମାଳା - ପ୍ର. କୃଷ୍ଣଚାନ୍ଦ୍ର ପ୍ରଧାନ

୭. ସର୍ବସାର ବ୍ୟାକରଣ - ଶ୍ରୀଧର ଦାସ ଓ ନାରାୟଣ ମହାପାତ୍ର

୮. ସାରସ୍ୱତ ବ୍ୟାବହାରିକ ବ୍ୟାକରଣ - ଡ. କୃଷ୍ଣଚାନ୍ଦ୍ର ପ୍ରଧାନ ଓ ସାଥୀ

Ability Enhancement Compulsory Course (AECC -II) Hindi
Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

हिन्दी भाषा, ब्याकरण एबं रचना

Unit I: हिन्दी के बिबिध रूप

(क) राजभाषा, संचारभाषा (श्रब्या माध्यम - दृश्य) (8)

(ख) सरकारी पत्र लेखन (ब्याबहरिक पक्ष) नमूना (8)

Unit II: अपाठीत गदयांश (8)

Unit III: अशुद्धि लेखन

(क) शब्द शुद्धिकरण (4)

(ख) वाक्य शुद्धिकरण (4)

Unit IV:शब्द ज्ञान

(क) पर्याय वाची (4)

(ख) अनेक शब्द केलिए एक शब्द (4)

Unit V: प्रशासनिक शब्दावली

(क) अँग्रेजी से हिन्दी (4)

(ख) हिन्दी से अँग्रेजी (4)

Unit I: यूनिट एक (क) बिभाग से एक प्रश्न एबं (ख) बिभाग से एक प्रश्न पुछे जाएंगे । एक का उत्तर लिखना होगा । (8)

Unit II: एक अपठित गद्दयांश दिया जाएगा । जिनमे से चार प्रश्न पूछे जाएंगे । चारों प्रश्नो का उत्तर देना अनिवार्य होगा । (8)

Unit III: (क) छः शब्द शुद्धिकरण के लिए दिये जाएंगे । चार का उत्तर लिखना होगा । (4)

(ख) छः वाक्य शुद्धिकरण के लिए दिये जाएंगे । चार का उत्तर लिखना होगा । (4)

Unit IV: (क) छः पर्यायवाची शब्द दिये जाएंगे , जिनमे से चार शब्दों का पर्यायवाची लिखना होगा । (4)

(ख) छः अनेक शब्दों के लिए एक शब्द दिये जाएंगे , जिनमे से चार का उत्तर लिकना होगा । (4)

Unit V: (क) छः अँग्रेजी शब्द दिये जाएंगे , जिनमे से चार का हिन्दी रूप लिखना होगा । (4)

(ख) छः हिन्दी शब्द दिये जाएंगे , जिनमे से चार का अँग्रेजी प्रतिरूप लिखना होगा । (4)

Physics GE II: Electricity, Magnetism and Electro Magnetic Theory

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Vector Analysis: Scalar and vector product, scaler and vector triple product,gradient , divergence , curl and their significance, Related problems, Vector Integration, Line , surface and volume integrals of Vector fields. Gauss Divergence Theorem and Stoke's Theorem of vectors (statement only).

Unit II: Electrostatics: Electrostatic field, Electric flux, Gauss's theorem of electrostatics. Application of Gauss Theorem—Electric field due to a point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet , charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole,uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

Unit III: Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation , Displacement vector. Gauss's theorem of Dielectrics. Parallel plate capacitor completely filled with dielectric and partly filled with dielectric, Di-electric constant.

Unit IV: Magnetism:
Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of a magnetic field. Magnetic vector potential. Ampere's law and its application to straight conductor and solenoid. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferromagnetic materials.

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Unit V: Maxwell's equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, Polarisation.

Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press
- Electricity and Magnetism, D.C. Tayal, 1988,Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn,1998, Benjamin Cummings.
- Electricity and Magnetism—K.K. Tewari (S.Chand Higher Academics)2013.

GE II LAB: ELECTRICITY, MAGNETISM AND EMT
Credits -02, Marks – 25,

1. To use a Multimeter for measuring (a) Resistances, (b)AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistics Galvanometer:
   (i) Measurement of charge and current sensitivity.
   (ii)Measurement of CDR.
   (iii)Determine a high resistance by Leakage Method.
   (iv) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study a series LCR circuit LCR and determine its (a) Resonant frequency, (b) Quality factor.
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorems.
10. To verify the Superposition, and Maxium Power Transfer Theorems.
11. Comparison of e.m.f.s by stretched wire potentiometer.
12. To study the magnified due to a circular current carrying coil.
13. Determination of M/H by Deflection Magnetometer.
14. End correction of Meter Bridge.

Reference Books

- Advanced Practical Physics for Students, B.L.Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced Level Physics Practicals, Michel Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed. 2011, Kitab Mahal.

Physics CC III: Electricity and Magnetism

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Electric Field and Electric Potential
Electric field: Electric field lines. Electric flux. Gauss's Law with application to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic field. Electrostatic Potential. Laplace and Poisson's equations.The Uniqueness Theorem. Potential and Electric field of a dipole. Force and Torque on a dipole.

Unit II: Electrostatic Energy of system of charges. Electrostatic energy of charged sphere. Conductor in an Electrostatic field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Cylindrical capacitor. Capacitance of an isolated conductor. Method of Images and its application to (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter: Electric Field in matter, Polarisation, Polarisation Charges, Electrical Susceptibility and Dielectric Constant, Capacitor (Parallel plate, spherical, cylindrical), filled with dielectric, Displacement vector D, Relations between E,P and D, Gauss's law in dielectrics.

Unit III: Magnetic Field: Magnetic force between current elements and definition of Magnetic field **B**, Biot-Savart's Law and its simple applications: straight wire, circular loop and solenoid, Current Loop as a magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: Curl and Divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a loop in a uniform magnetic field. Ballistic Galvanometer, Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping.CDR

Unit IV: Magnetic Properties of Matter: Magnetization vector(**M**), Magnetic Intensity(**H**).Magnetic Susceptibility and permeability. Relation between **B,H,M**. Dia, Para & Ferromagnetic Materials, **B-H** curve and hysteresis.

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Self Inductance of a solenoid, mutual inductance of two co-axial coils. Energy stored in a magnetic field.

Unit V: Electrical Circuits: AC Circuits containing L-R,C-R,L-C-R circuits. Reactance, Impedance, Admittance, Susceptance, Series LCR Circuit (1) Resonance, (2) Power Dissipation and (3) Quality Factor and (4) Band Width. Parallel LCR Circuit.

Network theorems: Ideal Constant-voltage and Constant Current Sources, Network Theorems, Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to dc circuits.

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S.Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B. Leighton, M.Sands, 2008,Pearson Education.
- Elements of Electromagnetics,M.N.O.Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol.I, 1991, Oxford Univ. Press.
- Electricity & Magnetism : Satyaprakash(Pragati Prakashan)
- Foundation of Electricity & Magnetism: Basudev Ghosh(Books & Allied Pvt. Ltd)

- Electricity & Magnetism: R.Murugeshan(S.Chand & Company Pvt. Ltd.)
- Electricity & Magnetism:K.K.Tiwari(S.Chand & Company Ltd.)
- Electricity & Magnetism:Seghal Chopra Seghal(Sultan Chand & Sons)

PHYSICS LAB-C III LAB: ELECTRICITY AND MAGNETISM
Credits -02, Marks – 25, 20 Lectures

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De-Sauty's bridge.
6. Measurement of field strength B and its variation in asolenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's Bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency, and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.
16. To study the magnetic field due to a current carrying circular coil.
17. To measure the horizontal component of Earth's Magnetic field using deflection and oscillation magnetometer.

Reference Books

- Advanced Practical Physics for students,B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for the undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.

Physics CC IV: Waves and Optics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Geometrical Optics: Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics, Defects of Images, Spherical & Chromatic aberration, Coma & Astigmatism and their elimination, Cardinals points of optical system. Idea of dispersion, Application to thick lense, Ramsden and Huygens eyepiece.

Unit II: Wave Motion: Plane and Spherical Waves, Longitudinal and Transverse Waves. Plane Progressive(Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy transport. Intensity of wave. Water Waves, Ripple and Gravity Waves.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures (1:1 and 1:2) and their uses. Superposition of N harmonic waves.

Unit III: Wave Optics: Electromagnetic nature of light, Definition and properties of wave front, Huygens Principle, Temporal and Spatial Coherence.

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: Parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes), Newton's Rings, Measurement of wavelength and refractive index. Michelson Interferometer, Fabry Perot Interferometer.

Unit IV: Fraunhofer diffraction: Single Slit, Circular Aperture, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating.

Unit V: Fresnel Diffraction: Fresnel's Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light. Theory of Zone Plate: Multiple Foci of a Zone plate. Fresnel's Integral, Fresnel diffraction pattern of straight edge, a slit and a wire.

Reference Books

- Waves: Berkeley Physics Course, Vol.3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
- Principles of Optics, Max Born and Emil Wolf, 7th Edn, 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw-Hill
- The Physics of Vibration and Waves, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations,N.K. Bajaj,1998, Tata McGraw Hill.
- Optics- Brijlal & Subramaniam-(S. Chand Publication)2014
- Geometrical & Physical Optics—R.S. Longhurst, Orient Blackswan, 01-jan-1986.
- Vibrations & Waves—A.P. French, (CBS) Indian print 2003.
- Optics, E. Hecth (Pearson India).
- Optics: Satyaprakash (Pragati Prakashan)
- Geometrical and Physical Optics: P.K. Chakravarty (New Central Book Agency (P) Ltd.)
- Introduction to Optics: Anchal Srivastava, Shukla & Pandya (New Age International Publishers).

PHYSICS LAB-CC IV LAB: WAVES AND OPTICS
Credits – 2 , Full Marks – 25

1. To determine the frequency of an electric tuning fork by Melde's Experiment and verify λ^2-T law.

2. To investigate the motion of coupled oscillators.

3. To study Lissajous figures.

4. Familiarization with : Schuster's focusing; determination of angle of prism.

5. To determine the refractive index of the Material of the prism using sodium source.

6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.

7. To determine the wavelength of sodium source using Michelson's interferometer.

8. To determine wavelength of sodium light using Fresnel Biprism.

9. To determine wavelength of sodium light using Newton's Rings.

10. To determine the thickness of a thin paper by measuring the width of a interference fringes produced by a wedge-shaped Film.

11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.

12. To determine dispersive power and resolving power of a plane diffraction grating.

13. To determine refractive index of the material of a prism by i-D curve method assuming $A=60^0$

14. Determine the diameter of a narrow vive.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971 , Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandewala, 1985 ,Vani
- An advance course in Practical Physics, Chattopadhyay & Rakshit.(New Central Book Agency(P))
- Practical Physics with Viva-voce. S.L. Gupta & V. Kumar.(Pragati Prakashan).
- University Practical Physics D.C. Tayal(Himalaya Publishing House).

SEMESTER-III

English SEC I: Communicative English & English writing skill

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

Unit I: Introduction to the essentials of Business Communication: Theory and practice
Communication: Definition, Process, Purpose, Communication Network, Types of Communication, Barriers to communication

Unit II: Mechanics of Writing
Stages of writing, Preparing Notes, Style and Tone, linguistic unity, coherence and cohesion, How to Compose Business Messages, Citing references, and using bibliographical

Unit III: Writing a project report
Report planning, Types of Reports, Developing an Outline, Sections of the Report

Unit IV: Writing minutes of meetings, Circular, Notices, Memos, Agenda

Unit V: E-correspondence: E-mails, Business Letter Format, Styles, Types of Letter

Suggested Readings:

1. Scot, O.; Contemporary *Business Communication*. Biztantra, New Delhi.
2. Lesikar, R.V. &Flatley, M.E.; *Basic Business Communication Skills for Empowering the Internet Generation*, Tata McGraw Hill Publishing Company Ltd. New Delhi.
3. Ludlow, R. & Panton, F.; *The Essence of Effective Communications*, Prentice Hall Of India Pvt. Ltd., New Delhi.
4. R. C. Bhatia, *Business Communication*, Ane Books Pvt Ltd, New Delhi

Physics GE III: Thermal Physics and Statistical Mechanics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Laws of Thermodynamics: Thermodynamic Description of System: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, various thermo dynamical process, Application of First Law: General Relation between Cp and Cv,Equation of States of and Adiabatic process, Work done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficient,

Unit II: Reversible and irreversible processes, Second law and Entropy, Carnot's Cycle & Carnot's Theorem, Entropy changes in reversible and irreversible processes, Entropy – temperature diagrams, Third laws of thermodynamics, Unattainability of absolute zero**.**

Unit III: Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relation and its applications—Joule-Thomson Effect, Clausius-Clapeyron equation, Expression for(C_P-C_V), C_P/ C_V, Tds equations.

Unit IV: Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its application to specific heat of gases; mono-atomic and diatomic gases.

Unit V: Theory of Radiation: Black body Radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's Distribution law, Rayleigh-Jeans Law, Stefan's Booltzmann Law and Wien's displacement law from Planck's law.

Statistical Mechanics:Maxwell-Boltzmann law-distribution of velocity- Quantum statistics- Phase space-Fermi-Dirac distribution law- electron gas- Bose-Einstein distribution law- photon gas- comparison of three statistics.

Reference Books:

- Thermal Physics, S.Garg, R.Bansal and C. Ghosh, 1993, Tata Mc Graw Hill
- A Treatise on Heat, Meghnad Saha and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger, 1988, Narosa
- University Physics, Ronald Lane Reese,2003, Thomson Brooks/Cole.
- Thermal and Statistical Physics—M.Das, P.K. Jena and others (Srikrishna Publication)
- Heat and Thermal Physics—Brijlal & Subramaniam (S.Chand Publication)2014
- Thermal Physics –C.Kittel and H. Kroemer (McMillan Education India)2010
- Thermodynamics and Statistical Physics—J.K. Sharma, K.K. Sarkar (Himalaya Pub) 2014
- Thermal Physics—J.P. Agrawal and Satyaprakash (Pragati Prakashan) 2015
- Thermal Physics –A.B. Gupta and H.P. Roy (Books and Allied Pvt. Ltd.)

GE III LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS

Credits – 2, Full Marks – 25,

1. To determine Mechanical Equivalent of Heat, J, by Callender and Brane's constant flow method.
2. Measurement of Planck's constant using blackbody radiation.
3. To determine the Stefan's constant.
4. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
5. To determine the coefficient of Thermal conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature coefficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyse the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system.
10. To calibrate Resistance Temperature Device (RTD) using Null method / Off- Balance Bridge.
11. To determine the Coefficient of Apparent Expansion of liquid using Weight Thermometer.
12. To determine the Latent Heat of Wax by Cooling Method.
13. To determine the Specific Heat of a liquid by method of cooling.
14. To determine the value of J by Joule's Calorimeter.
15. To determine the Specific Heat of Solid using radiation correction.

Reference Books:

- Advanced Practical Physics for Students, B.L. Flint & H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash & Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual for Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Physics CC V: Mathematical Physics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

The emphasis of the course is on application in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Unit I: Fourier series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Condition(Statement only). Expansion of Periodic functions in a series of sine and cosine functions and determination of Fourier Coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non- periodic functions over an interval. Even and odd functions and their Fourier expansions. Applications. Summing of Infinite series. Term-by- Term differentiation and integration of Fourier series. Parseval Identity.

Unit II: Some Special Integrals: Beta and Gamma Functions & their properties, Relation between Beta & Gamma function. Expression of integrals in terms of Gamma Function. Duplication formula, Error Function(Probability Integral).

Unit III: Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations: Legendre & Hermite Differential Equations. Properties of Legendre & Hermite Polynomials: Rodrigues Formula, Generating Function, Orthogonality, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials, Associated Legendre polynomials and spherical harmonics.

Unit IV: Theory of Errors: Systematic and Random Errors, Error due to approximation of function, error in a series approximation. Propagation of Errors. Normal Law of Errors. Standard and Probable error.

Unit V: Partial Differential Equations: Solutions to partial differential equations using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched strings.

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Mathematical Methods for Scientists & Engineers, D.A. McQuarrie,2003, Viva Books.
- Mathematical Physics and Special Relativity—M.Das, P.K,Jena and B.K. Dash (Saikrishna Prakashan) 2nd Edition 2009.
- Mathematical Physics—H.K. Dass, Dr.Rama Verma(S.Chand Higher Academadics) 6th Edition 2011.
- Mathematical Physics-C.Harper,(Prentice Hall India) 2006
- Mathematical Physics-Goswami (CENGAGE Learning) 2014
- Mathematical Method for Physical Sciences-M.L. Boas (Wiley India) 2006
- Mathematics for Physicist P. Dennery and Krzywicki Dover)

PHYSICS LAB-C V LAB: MATHEMATICAL PHYSICS

Credits – 2, Full Marks – 25, 20 Lectures

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lecturers (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics	Description with Applications
Introduction to Numerical computation software scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimentional arrays, Subarray, Special Values, Displaying output data, Data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting,2D and 3D plotting(2), Branching Statements and programme design, Relational and logical operators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorisation (2) User defined functions, Introduction to scilab functions, variable passing in scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/O functions, Comparing binary and formatted functions, Numerical methods and developing the skills of writing a programme (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant.
Solution of linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems.	Solution of mesh equations of electric circuits(3meshes) Solution of coupled spring mass systems (3meshes)
Solution of ODE First order Differential equation, Euler, modified Euler and Runge-Kutta second order methods Second order differential equation. Fixed difference method.	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Second order differential equation • Harmonic oscillator (no friction) • Damped Harmonic Oscillator • Over damped • Oscillatory • Forced Harmonic oscillator • Transient and • Steady state solution • Apply above to LCR circuits also.

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F.Riley, M.P. Hobson and S.J.Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Simulation of ODE/PDE Models with MATLAB R, OCTAVE and SCILAB: Scientific and Engineering Applications. A.V. Wouwer, P.Saucez,C.V. Fernandez, 2014 Springer
- Scilab by example: M.Affouf 2012, ISBN:978-14792034444
- Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair.2011 S.Chand & Company

Physics CC VI: Thermal Physics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)
(Include related problems for each topic)

Unit I: Introduction to Thermodynamics
Recapitulation of Zeroth and First law of thermodynamics.

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines, Carnot's Cycle, Carnot engine and efficiency. Refrigerator & coefficient of performance, 2^{nd} law of thermodynamics: KelvinPlanck and Clausius Statements and their equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit II: Entropy: Concept of Entropy, Clausius theorem, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a Perfect Gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Principle of Increase of Entropy. Temperature-Entropy diagrams for Carnot's Cycle. Third law of Thermodynamics, Unattainability of Absolute Zero.

Unit III: Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's free Energy, Their Definitions, Properties and Applications, Surface Films and Variation of Surface tension with Temperature, Magnetic Work, Cooling due to adiabatic demagnetization. Clausius Clapeyron Equation and Ehrenfest equations.

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's relations, Maxwell's relations: (1) Clausius Claperyon equation, (2) Calues of Cp-Cv, (3) Tds Equations, (4) Joule – Kelvin coefficient for ideal and Vander Waal Gases, (5)Energy equations, (6) Change of Temperature during Adiabatic Process.

Kinetic theory of Gases

Unit IV: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas,Stern's Experiment. Mean, RMS and Most Probable speeds, Degrees of Freedom, Law of Equipartition of Energy (No proof required), Specific heats of Gases.

Molecular Collisions: Mean Free Path, Estimates of Mean Free Path, Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) thermal Conductivity and (3) Diffusion.

Unit V: Real Gases: Behavior of real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Results of Andrew's experiments on CO_2 Gas, Critical Constants, Vapour and Gas, Boyle Temperature, Van der Waal's Equation of State for real Gases. Values of Critical Constants. Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule-Thomson Porous Plug Experiment , Joule-Thomson Effect for Real and Vanderwaal Gases, Temperature of Inversion, Joule-Thomson Cooling.

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A treatise on Heat, Meghanad Saha and B.N. Srivastava,1958, Indian Press
- Thermal Physics, S.Garg, R.Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S.Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J.Blundell, 2nd Ed., 2012, Oxford University Press.
- Heat and Thermal Physics-Brijlal & Subramaiam (S.Chand Publication) 2014
- Thermal Physics-C.Kittel and H. Kroemer (McMillan Education India)2010
- Thermal Physics: J.P. Agrawal & Satyaprakash(Pragatiprakashan) 2015
- Thermal Physics, A.B Gupta & H.P. Roy(Books 7 Allied (P) Ltd.)
- Theory & Experiment in Thermal Physics: P.K. Chakravarty(New Central Book Agency(P) Ltd.)
- Thermal & Statistical Physics: Das, Jena,Mishra & Mishra(Srikrishna Prakashan)

PHYSICS LAB-C VI LAB: THERMAL PHYSICS

Credits – 2, Full Marks – 25, 20 Lectures

1. To determine Mechanical Equivalent of Heat, J, by Callender and Brane's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Amstrong's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee & Charlton's disc method.
5. To determine the Temperature Coefficient Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its two junctions.
7. To calibrate a thermocouple to measure temperature in a specific range using (1) Null Method, (2) Direct measurement using Op-Amp difference Amplifier and to determine Neutral Temperature.
8. To determine J by Caloriemeter.
9. Determination of Specific heat of liquid by Newton's law of Cooling.
10. Latent heat of wax by cooling method.
11. Coefficient apparent expansion by weight thermometer.
12. Specific heat of solid by using radiation correction.
13. Latent heat of ice using radiation correction.

Reference Books

- Advanced Practical Physics for students, B.L. Flint & H.T.Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011 Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and John M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandewala, 1985 , Vani Pub.

Physics CC VII: Digital System and Applications

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Integrated Circuits (Qualitative treatment only): Active and Passive Components. Discrete Components. Wafer, Chip. Advantages and drawbacks of ICs. Examples of Linear and Digital ICs**. (3 Lectures)**

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal Numbers. AND, OR & NOT Gates (realization using Diodes and Transistors). NAND and NOR Gates as Universal Gates. XOR & XNOR Gates and application as Parity Checkers.

Unit II: Boolean Algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra . Fundamental Products. Idea of Minterms and Maxterms . Conversion of a truth table to Equivalent Logic Circuit by (1) Sum of Product Method and (2) Karnaugh's Map.
Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO:(1) Study of Waveform,(2) Measurement of Voltage, Current , Frequency and Phase Difference.

Unit III: Data Processing Circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders**.**
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half and Full Subtractors, 4-bit binary Adder/Subtractor.

Unit IV: Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Introduction to Computer Organization: Input/Output Devices. Data Storage (idea of RAM & ROM). Computer memory. Memory Organization and addressing. Memory Interfacing . Memory Map.

Unit V: Shifts registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift registers (only up to 4 bits).
Counters (4bits): Ring Counter. Asynchronous Counters, Decade Counter. Synchronous Counter.

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal,2011 , Tata McGraw Hill.
- Digital Systems: Principles and Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal,2012, Cengage Learning.
- Microprocessor Architecture Programming and application with 8085, 2002, R.S. Goanker, Prentice Hall.
- Concept of Electronics: D.C. Tayal (Himalay Publication) 2011
- Electronics :V.K. Meheta(S. Chand Publication)2013

PHYSICS PRACTICAL-C VII LAB:
DIGITAL SYSTEM AND APPLICATIONS
Credits – 2, Full Marks – 25, 20 Lectures

1. To measure (a) Voltage, (b) Time Period of periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design switch(NOT gate) using a transistor.
4. To verify and design AND, OR,NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuit using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs.
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs
14. To design an astable multivibrator of given specification using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.

Reference Books

- Modern Digital Electronics, R.P. Jain, 4th Edititon, 2010, McGraw Hill.
- Basic Electronics: A text book lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, McGraw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

SEMESTER IV

Physics SEC II: Renewable Energy and Energy Harvesting

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible.

Unit I: Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources, An overview of developments in offshore wind Energy, Tidal energy, Wave energy systems, Ocean thermal energy Conversion, Solar energy, Bio mass, biochemical conversion, bio gas generation, geothermal energy, tidal energy, Hydroelectricity.

Unit II: Solar energy: Solar energy and its importance, storage of solar energy, solar pond, non plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning, Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits and sun tracking systems

Unit III: Wind Energy Harvesting: Fundamentals of Wind Energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces and grid interconnection topologies.

Unit IV: Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Unit V: Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Reference Books:

- Non-conventional energy sources-G.D. Rai-Khanna Publishers, New Delhi.
- Solar energy- M.P. Agarwal-S.Chand and Co. Ltd.
- Solar energy- Suhas P Sukhative Tata McGraw-Hill Publishing Company Ltd.
- Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with the Open University.
- Dr.P.Jayakumar, Solar Energy: Resource Assesment Handbook, 2009.
- J.Balfour, M.Shaw and S.Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

Physics GE IV: Waves and Optics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Fluids: Surface Tension: Synclastic and anticlastic surface- Excess of Pressure, Pressure difference across a curved surface- Application to spherical and cylindrical drops and bubbles- variation of surface tension with temperature – Jaegar's Method. Viscosity- Rate of flow of liquid in a capillary tube- Poiseuille's formula- Determination of coefficient of viscosity of a liquid- Variation of viscosity of liquid with temperature- lubrication, stoke's law in viscous medium

Unit II: Sound: Simple Harmonic Motion- Forced vibration and Resonance- Fourier' theorem- Application to saw tooth wave and square wave- Intensity and loudness of sound- Decibels- Intensity levels-musical notes- musical scale. Acoustics of Buildings: Reverberation and time – Acoustics aspects of halls and Auditoria.

Unit III: Superposition of two Perpendicular Harmonic Oscillation: Graphical and Analytical Methods. Lissajous figures (1:1 and 1:2) and their uses.

Wave Motion- General: Transverse wave on a string , Travelling and standing wave on a string. Normal Modes of String. Group Velocity and Phase Velocity. Plane waves. Spherical Waves, Wave Intensity.

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle (statement).

Unit IV: Interference: interference : Division of amplitude and division of wave front. Young's Double Slit Experiment . Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stoke's treatment. Interference in thin Films: parallel and wedge-shaped films, Fringe of equal inclination (Hidinger fringes); Fringes of equal thickness (Fizeau fringes). Newton's Ring: Measurement of wavelength and refractive index.

Unit V: Michelson's Interferometer: (1) Idea of form of fringes (no theory needed), (2) Determination of wavelength, (3) Wavelength difference, (4) Refractive index and (5) Visibility of Fringes.

Diffraction: Fraunhofer diffraction- Single slit; Duoble slit. Multiple slits and diffraction grating. Fresnel diffraction: Half-period zones. Zone plate. Fresnel diffraction pattern of straight edge, a slit and a wire using half-period zone analysis.

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.

Reference Books:

- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1976 , Mc Graw Hill
- Principle of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics , H.R. Gulati and D.R. Khanna, 1991, S.Chand Publications
- University Physics. Sears, Zeemansky and Young, 13/e, 1986, Addison-Wesley
- Optics- Satyaprakash (Pragati Prakashan)
- Geometrical and Physical Optics- P.K. Chakravarty (New Central Book Agency)
- Introduction to Optics: Anchal Srivastav, Shukla and Pandya (New Age International Publishers)

PHYSICS GE IV LAB: WAVE AND OPTICS

Credits – 2, Full Marks – 25, 60 Lectures

1. To investigate the motion of couple oscillators.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2-T Law.
3. To study Lissajous Figure.
4. Familiarization with Schuster's focusing; determination of angle of prism.
5. To determine the coefficient of Viscosity of water by Capillary Flow Method (Poseuille's method)
6. To determine the Refractive Index of the Material of the Prism using Sodium Light .
7. To determine Dispersive Power of the Material of the Prism using Mercury Light .
8. To determine the value of Cauchy Constant.
9. To determine the Resolving Power of a Prism.
10. To determine the wavelength of sodium light using Fresnel Biprism.
11. To determine the wavelength of sodium light using Newton's Ring.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating.
14. To determine the Resolving Power of a Plane Diffraction Grating .
15. To Measure the Intensity using photo sensor and laser in diffraction patterns of single and double slits.
16. To determine Magnifying Power of Telescope.
17. To determine the Refractive Index of a liquid by travelling microscope.
18. To determine the Radius of Curvature of a Convex Mirror by Kohlraush's Method.

Reference Books:

- Advanced Practical Physics for Students, B.L.Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn,4th Edition, reprinted 1985,Heinemann Educational Publishers
- A Text Book of Practical Physics , Indu Prakash and Ramakrishna, !!th Edition, 2011, Kitab Mahal , New Delhi.

Physics CC VIII: Mathematical Physics-III

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

The emphasis of the course is on application in solving problems of interest to Physicists. Students are to be examined on the basis of problems, seen and unseen.

Unit I: Complex Analysis: Brief Revision of Complex Number and their Graphical Representation. Euler's formula. De Moivre's Theorem, Root of Complex Numbers. Function of Complex Variables. Analyticity and Cauchy-Riemann Conditions.Application of Cauchy-Riemann Conditions to simple problems.

Unit II: Example of analytic functions. Singular Functions: Poles and Branch points, order of singularity, branch cuts. Integration of function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and Multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Unit III : Integral Transforms:
Fourier Transforms: Fourier Integral Theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train and other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives. Inverse Fourier Transform.

Unit IV: Convolution Theorem**:** Properties of Fourier Transforms (translation, change of scale, complex conjugation, etc.) Three dimensional Fourier transform with examples. Application of Fourier Transform to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Unit V: Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of derivatives and integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta functions, Periodic functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F. Riley, M.P. Hobsons and S.J. Bence, 3rd ed.,2006, Cambridge University Press
- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Advanced Engineering Mathematics, E. Kreyszig(New Age Publication) 2011
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967 , Dover Publications
- Complex Variables, A.S. Fokas& M.J. Ablowitz, 8th Ed.,2011, Cambridge Univ. Press
- Complex Variable and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, John & Bartlett.
- Mathematical Physics—H.K. Dass, Dr. Rama Verma (S. Chand Higher Academics), 6th Edition 2011.
- Mathematical Physics—C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics- Goswami(Cengage Learning) 2014
- Mathematical Method for Physical Sciences—M.L. Boas (Wiley India) 2006

- Introduction to the theory of function of complex variable- E.T. Copson (Oxford) Univ. Press, 1970
- Mathematical Physics: A.B. Gupta (Books and Allied (P) Ltd.)

PHYSICS PRACTICAL - CC VIII LAB: MATHEMATICAL PHYSICS-III

Credits – 2, Full Marks – 25, 20 Lectures

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:

   $dy/dx=e^{-x}$ with y=0 for x=0

   $dy/dx+ e^{-x}y=x^2$

   $d^2y/dt^2+2dy/dt=-y$

   $d^2y/dt^2=e^{-t}dy/dt=-y$

2. Dirac Delta Function:

   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)dx$ for σ=1,0.1,0.01 and show it tend to 5

3. Fourier Series:

Program to sum $\sum_{n=1}^{\infty}(0.2)^n$

Evaluate the Fourier Coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

$$\int_{-1}^{1} P_n(\mu)P_m(\mu)d\mu = \delta n,m$$

Plot $P_n(x)$,$J_V(x)$

Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. sinθ, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check without computer integration.

8. Integral transform: FFT of e^{-x2}

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F. Riley, M.P. Hobson and S.J. Bence, 3rd ed., 2006, Cambridge University Press.
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernandez. 2014, Springer ISBN:978-3319067896
- Scilab by example: M. Affouf, 2012, ISBN:978-1479203444
- Scilab (aA free software to Matlab): H. Ramachandran, A.S. Nair. 2011, S. Chand & Company
- Scilab Image Processing : Lambert A. Surhone. 2010, Betascript Publishing.

Physics CC IX: Elements of Modern Physics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Atomic Spectra and Models

Inadequacy of Classical Physics, Brief Review of Black Body Radiation, Photoelectric Effect, Compton effect, dual nature of radiation, wave nature of particles. Atomic Spectra, Line Spectra of Hydrogen atom, Ritz Rydberg Combination Principle.

Unit II: Alpha Particle Scattering , Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohr's Model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitation of Bohr Model, Descrete energy exchange by atom , Frank Hertz Expt. Somerfeld's modification OF Bohr's Theory.

Unit III: Wave Particle Duality

De Broglie hypothesis, Experimental confirmation of matter wave, Davission Germer Experiment, Velocity of de Broglie wave, wave particle duality,Complementarity. Superposition of two waves,phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time. Time Development of a wave packet; wave particle duality, Complementarity.

Unit IV: Heisenberg Uncertainty Principle, Illustration of Principle through thought experiment of Gamma ray microscope and electron diffraction through a slit. Estimation of ground state energy of harmonic oscillator and hydrogen atom, non existence of electron in the nucleus. Uncertainty and Complementarities.

Nuclear Physics

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear Force, NZ graph, Liquid Drop Model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

Unit V: Radioactivity: Stability of the nucleus; Laws of radioactive decay; Mea-life and Half-life; Alpha decay; Beta decay- energy released, Spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of nucleus.

Fission and fusion- mass deficit, relativity and generation of energy; Fission- nature of fragments and emission f neutrons. Nuclear Reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy(brief qualitative discussions).

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard,Coop, 2002,Tata McGraw-Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for Scientists and Engineers with Modern Physics, Jewett and Serway,2010, Cengage Learning.
- Quantum Mechanics: Theory and Applications, A.K. Ghatak & S. Lokanathan,2004, Macmillan

- Modern Physics—Berstein , Fishbane and Gasiorowicz (Pearson India) 2010
- Quantum Physics of Atoms, Molecules, Solids ,Nuclei and Particles—R.Eisberg(Wiley India)2012

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson,2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tta McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 1971, Tata McGRAW-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K. Heydee,3rd Edn., Instsitute of Physics Pub.
- Six Ideas that shaped Physics: Particle behaves like waves, T.A. Moore, 2003, McGraw-Hill
- Modern Physics-Serway(CENGAGE Learnings)2014
- Physics of Atoms and Molecules—Brandsen (Pearson India)2003
- Fundamental of Modern Physics- Agarwal and Agarwal (Pragati Prakashan)
- Quantum Mechanics:Satyaprakash (Pragati Prakashan)
- Modern Atomic and Nuclear Physics: A.B. Gupta (Books & Allied (P) Ltd)
- Introduction to Quantum Mechanics: M. Das & P.K. Jena (Srikrishna Prakashan)
- Nuclear Physics an Introduction:S.B. Patel(Wiley Eastern Limited)

PHYSICS PRACTICALS CC IX LAB: ELEMENTS OF MODERN PHYSICS

Credits – 2, Full Marks – 25, 20 Lectures

1. Measurement of Planck's constant using Black body radiation and Photo-dector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar Magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wave length of laser source using diffraction of single slit.
12. To determine the wave length of laser source using diffraction of double slit.
13. To determine (1) wave length and (2) angular speed of He-Ne laser using plane diffraction grating.
14. Determination of resistivity and band gap of intrinsic semi conductor by four probe method
15. Verification of R-D law

Reference books:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, 1985, Heinemann Educational Publishers

Physics CC X: Analog Systems and Applications

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Semiconductor Diodes: and N type semiconductors, Energy Level Diagram, Conductivity and Mobility, Concept of Drift velocity. PN junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

Two-terminal Devices and their Applications: (1).Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers. Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and Structure of (1) LEDs, (2) Photodiode ,(3) Solar Cell.

Unit II: Bipolar Junction transistors: n-p-n and p-n-p Transistors, Characteristics of CB, CE and CC Configurations. Current gains Alpha & Beta. Relations between Alpha and Beta, Load Line analysis of Transistors, DC Load Line and Q Point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Unit III: Amplifiers: Transistor Biasing and Stabilisation Circuits, Fixed Bias and Voltage Divider Bias. Transistor as 2-Port Network. H-parameter, Equivalent Circuit, Analysis of a single-stage CE amplifier using hybrid model, Input and Output impedance. Current, Voltage and Power Gains. Classification of Class A, B &C Amplifiers.

Coupled Amplifier: R-C Coupled amplifier and its frequency response.

Unit IV: Feedback in Amplifiers: Effects of positive and Negative Feedback on Input impedance, Output Impedance, Gain, Stability, Distortion and Noise.
Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations, RC phase shift oscillator, determination of Frequency, Hartley & Colpitts oscillators.

Unit V: Operational Amplifiers (Black Box Approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open and Closed-Loop Gain. Frequency Response. CMRR, Slew Rate and Concept of Virtual ground.

Applications of Op-Amps: (1). Inverting and Non-Inverting amplifiers, (2) Adder, (3) Subtractor, (4)Differentiator, (5) Integrator, (6) Log Amplifier, (7) Zero Crossing detector (8) wein Bridge Oscillator.

Reference Books:

- Integrated Electronics, J.Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Reyder, 2004, Prentice Hall.
- Solid State Electronic devices, B.G. Streetman & S.K. Banerjee, 6th Edn., 2009, PHI Learning
- Electronic Devices & Circuits, S.Salivahanan & N.S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
- Op-Amps and Linear Integrated Circuit, R.A. Gayakwad, 4th Edition, 2000, Prentice Hall.
- Electronics Circuits: Handbook of Design and Applications, U.Tietze, C.Schenk, 2008, Springer.
- Semiconductor Devices:Physics and Technology,S.M. Sze, 2nd Ed., 2002, Wiley India.

- Electronics Devices: 7/e Thomas L. Floyd, 2008, Pearson India.
- Concept of Electronics: D.C. Tayal (Himalay Publication)
- Electronics Devices: Circuits & Applications: W.D. Stanley, Prentice Hall.
- Electronics: V.K. Meheta(S. Chand Publication) 2013
- Electronics Circuits: L. Schilling and Velove: 3rd , McGraw Hill
- Electronics: Raskhit & Chattopadhyay (New age International Publication) 2011
- Electricity & Electronics- D.C. Tayal (Himalay Publication)2011
- Electronic Devices & Circuits—R.L. Boylstad (Pearson India) 2009

PHYSICS PRACTICAL - CC X LAB:
ANALOG SYSTEMS AND APPLICATIONS
Credits – 2, Full Marks – 25,

1. To study V-I characteristics of PN junction diode and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its uses as voltage regulator.
3. Study of V-I and power curves of a solar cell, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar junction Transistor in CE configuration.
5. To study the various biasing configuration of BJT FOR NORMAL class A operation.
6. To design a CE transistor amplifier if a given gain(mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for a given frequency using an op-amp.
9. To design a phase shift oscillator of given specification using BJT.
10. To study the Colpitt's oscillator.
11. To design a digital to analog convertor (DAC) of given specification.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response.
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response.
16. To study the zero-crossing detector and comparator.
17. To add two dc voltages using Op-amp in inverting and non-inverting mode.
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of Op-amp as an integrator.
20. To investigate the use of Op-amp as a Differentiator.
21. To design a circuit to stimulate the solution of a 1st /2nd order differential equation.

Reference Books:

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino,M.A. Miller,1994, McGraw-Hill.
- OP-Amp & Linear Integrated Circuit, R.A. Gayakwad, 4th edition,2000, Prentice Hall.
- Electronic Principle, Albert Malvino,2008, McGraw-Hill.
- Electronics Devices and Circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson.

SEMESTER- V

Physics DSE I: Classical Dynamics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Answer any two questions from Section-A and three question from Section-B)

SECTION - A

Classical Mechanics of Point Particles: Generalised coordinates and velocities . Hamilton's Principle, Lagrangian and Eluer-Lagrangian equat6ions. Application to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equation of Motion. Application: Hamilton for harmonic oscillator, particle in a central force field. Motion of charged particles in external electric and magnetic fields.

SECTION - B

Special Theory of Relativity: Postulate of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dialation, length contraction & twin paradox. Four vectors: space-like, time-like & light-like. Four velocity and acceleration. Metric and alternating tensors. Four–momentum and energy-momentum relation. Doppler's effect from a four vector perspective. Concept of four forces. Conservation of four momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Reference Books:

- Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edn.,20002, Pearson Education.
- Mechanics, L.D. Landua and E.M. Lifshitz,1976, Pergamon.
- Classical Mechasnics: An Introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in Classical Mechanics, O.L. Delange and J. Pierrus,2010, Oxford Press.
- Classical Mechanics: J.C Upadhyay(Himalaya Publication) 2014
- Classical Dynamics of Particles and Systems—S.T. Thornton (Cengage Learning) 2012
- Introduction to Classical Mechanics—R.K. Takwale, S. Puranik-(Tata Mc Graw Hill)
- Classical Mechanics- M. Das, P.K. Jena, M.Bhuyan, R.N. Mishra (Srikrishna Prakashan)

DSE I: Project
Credits – 2, Full Marks – 25,

Physics DSE II: Nuclear and Particle Physics

(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: General Properties of Nuclei: Constituents of Nucleus and their Intrinsic properties, quantitive facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnet moment, electric moments, nuclear excites states**.**

Unit II: Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, conditions of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model**.**

Unit III: Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, (b).β-deacy: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Elementary idea of Gamma decay.

Nuclear Reactions: Types of Reactions, Conservation laws, kinematics of reactions, Q-value**.**

Unit IV: Detector for Nuclear radiations: Gas detectors, estimation of electric field, mobility of particle, for ionization chamber and GM Counter, Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT), Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Unit V: Particle Accelerators: Van-de Graaff Generator (Tandem accelerator), Linear Accelerator, Cyclotron, Synchrotrons.

Particle Physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum , angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm. Elementary ideas of quarks and gluons.

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008)
- Concept of nuclear Physics by Bernad L. Cohen.(Tata Mcgraw Hill, 1998)
- Introduction to High Energy Physics, D.H. Perkins,(Cambridge Univ. Press)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Basics ideas and Concept in Nuclear Physics- An Introductory approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Theoretical Nuclear Physics-J.M. Blatt & V.F. Weisskopf (Dover Pub. Inc., 1991)
- Atomic and Nuclear Physics-A.B. Gupta, Dipak Ghosh.(Books and Allied Publishers)
- Physics of Atoms and Molecules-Bransden (Person India) 2003
- Subatomic Physics-Henley and Gracia (World Scientific) 2012
- Introduction to Nuclear and Particle Physics-A.Das and T.Ferbel (World scientific)
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000)
- Nuclear Physics: S.N. Ghosal (S.Chand & Company Pvt. Ltd.)
- Modern Atomic & Nuclear Physics: A.B. Gupta (Books & Allied (P) Ltd.)

DSE II: Project,

Credits – 2, Full Marks – 25,

Physics CC XI: Quantum Mechanics and Applications

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Schrodinger Equation & the Operators: Time dependent Schrodinger equation and dynamical evolution of quantum state; Properties of Wave Function. Interpretation of Wave Function. Probability and probability current densities in three dimensions; Conditions for Physical acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Hermitian Operator, Eigen values and Eigen functions. Position ,momentum and energy operators; commutator of position and momentum operators; expectation values of position and momentum. Wave Function of free particle**.**

Unit II: Time Independent Schrodinger Equation: Hamiltonian, stationary state and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension ; wave packets, Fourier transforms and momentum space wave function; Position-Momentum uncertainty Principle.

Unit III : General discussion of bound states in an arbitrary potential- Continuity of wave function, boundary conditions and emergence of discrete energy levels; Application to one dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator- energy levels and energy eigen functions ground state, zero point energy & uncertainty principle.

Unit IV: One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension- across a step potential & rectangular potential barrier.

Unit V: Atoms in Electric and Magnetic fields: Electron angular momentum. Space quantization. Electron spin and spin angular momentum, Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlac Experiment. Zeeman Effect: Electromagnetic Moment and Magnetic Energy.Gyromagnetic Ratio and Bohr's Magneton.

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect(Qualitative discussion only).

Reference Books:

- A Text Book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Ed.,2010, McGraw-Hill.
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn ,2002, Wiley
- Quantum Mechanics , Leonard I. Schiff, 3rd Edn, 2010, Tata McGraw-Hill
- Quantum Mechanics , G.Aruldhas, 2nd Edn, 2002, PHI Learning of India
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bertlett Learning
- Quantum Mechanics : Foundation and Applications, Arno Bohm, 3rd Edn., 1993, Springer
- Quantum Mechanics for Scientists and Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Physics—S. Gasiorowicz (Wiley India) 2013
- Quantum Mechanics –J.L. Powell and B.Craseman (Narosa) 1988
- Introduction to Quantum Mechanics—M. Das, P.K. Jena (Srikrishna Prakashan)
- Basic Quantum Mechanics—A.Ghatak (Mc Millan India)2012
- Introduction to Quantum Mechanics –R. Dicke and J. Wittke.
- Quantum Mechanics—Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introducton to Quantum Mechanics, D.J. Griffith, 2nd Ed.,2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

- Quantum Mechanics –F. Mandl (CBS) 2013
- Cohen Tannoudji , B Diu and F Laloë, Quantum Mechanics (2vols) Wiley-VCH 1977
- Quantum Mechanics , Satyaprakash (Kedarnath Ramnath, Merut/ Delhi)
- Quantum Mechanics: Chatwal & Anad (Himalay Publishing House)

PHYSICS PRACTICAL CC XI LAB:
QUANTUM MECHANICS AND APPLICATIONS
Credits – 2, Full Marks – 25,

Use C/C++/ Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:
   Here, m is the reduced mass of the electron. Obtain the energy eigen values and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈-13.6Ev. Take e=3.795(eVÅ)1/2, hc=1973 (eVÅ) and m=0.511x106 Ev/c2.
2. Solve the s-wave radial Schrodinger for an atom:
   Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened column potential
   Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also plot the corresponding wave functions. Take e=3.795 (eVÅ)1/2, m= 0.511x106Ev/c2, and a=3Å,5 Å, 7 Å. In these unit hc = 1973(eVÅ). The ground state energy is expected to be above -12Ev in all three cases.
3. Solve the s-wave Schrodinger equation for a particle of mass m: for the anharmonic oscillator potential
   For the ground state energy (in MeV) of particle to an accuracy of three significant digits.Also, plot the corresponding wave function. Choose m = 940MeV/c2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}. In these units, ch =197.3 MeV fm. The ground state energy I expected to lie between 90and 110 MeV for all three cases.
4. Sove the s-wave radial Schrodinger equation for the vibration of hydrogen molecule:
   Where μ is the reduced mass of the two atom system for the Morse potential
   Find the lowest vibration energy (in MeV) of the molecule to an accuracy of three significant digits. Also ,plot the corresponding wave function
   Take m =940x106Ev/c2, D=0.755501Ev,α =1.44, ro =0.131349Å.

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics
8. Quantum efficiency of CCDs

Reference Books:

- Schaum's outline of Programming with C++, J. Hubbard, 2000, McGraw-Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press
- An Introduction to Computational Physics, T. Pang , 2nd Edn,2006, Cambridge Univ. Press

- ,Simulation of ODE/PDE Models with MTLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernandez. 2014 , Springer
- Scilab (A free software to Matlab): H. Ramachandran, A.S. Nair, 2011, S. Chand & Co.
- Scilab Image Processing: L.M. Surhone. 2010, Betascript Publishing ISBN:978-6133459274

Physics CC XII: Solid State Physics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Crystal Structure: Solids; Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis—Central and Non-Central Elements. Unit cell. Miller Indices. Types of Lattices, Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Unit II: Elementary Lattice Dynamics: Lattice Vibration and Phonons: Linear Monatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonons Spectrum in Solids. Dulong and Petit's Law. Einstein and Debey Theories of Speific heat of Solids. T^3 Law.

Magnetic Properties of Matter: Dia-,Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia and Paramagnetic Domains. Curie's Law. Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Unit III: Dielectric Properties of Materials: Polarization. Local electric field at an atom. Depolarisation Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability.

Lasers: Einstein's A and B Coefficients. Metastable states. Spontaneous and Stimulated Emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

Unit IV: Elementary Band Theory: Krinig Penny Model. Band Gap. Conductor, Semiconductor (P and N type) and Insulator. Conductivity of Semiconductor. Mobility, Hall Effect. Measurement of Conductivity(04 probe method) & Hall Coefficients.

Unit V: Superconductivity: Experimental Results. Critical Temperature. Critical Magnetic Field. Meissner Effect. Type I and Type II Supercoductor. London's Equation and Penetration Depth. Isotope Effect. Idea of BCS Theory (No derivation).

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition,2006, Prentice all of India
- Introduction to Solids, Leonid V. Azaroff, 20004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976 Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 20009, Springer
- Solid State Physics , M.A. Wahab, 2011 , Narosa Publication

- Solid State Physics—S.O PIllai (New Age Publication)
- Solid State Physics – R.K. Puri& V.K. Babbar (S.Chand Publication) 2013
- Lasers and Non-linear Optics—B.B. Laud- Wiley Estern.
- LASERS: Fundamental and Applications—Thyagarajan and Ghatak(McMillan India)

PHYSICS PRACTICAL CC XII LAB: SOLID STATE PHYSICS

Credits – 2, Full Marks – 25,

1. Measurement of Susceptibility of Paramagnetic solution (Quinck's Tube Method)
2. To Measure the Magnetic Susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric Crystal .
4. To measure the Dielectric constants of a dielectric materials by Lecherwire
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasma Resonance.
6. To determine the refractive index of dielectric lasers using SPR.
7. To study the PE Hysteresis loop of a ferroelectric Crystal.
8. To draw the BH Curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method(room temperature to 150^0C) and to determine its band gap.
10. To determine the Hall Coefficient of a Semiconductor sample.
11. Study of Lissajous tiqur using CRO
12. Measurement of absorption coefficient by GM counter.
13. Study of Hall effect.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced Level Physics Practicals , Michael Nelson and John M. Ogborn, 4th Edititon,reprinted 1985, Heinmann Educational Publishers.
- A Text Book of Practical Physics , I. Prakash & Ramakrishna, 11th Ed.,2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastav, 2nd Ed., 2006, Prentice Hall of India.

SEMESTER VI

Physics DSE III: Computational Physics

(Credits: Theory-04, Project-02)

Full Marks: 75 (Midterm – 15+ End term – 60)

(To answer one question from Sec-A, two questions from Sec-B & two question from Sec-C)

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlight the use of computational method to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*
- *Course will consist of hands on training on the Problems solving on Computers.*

Section A: Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage linux as a an editor. Algorithm and Flowchart: Algorithm: Definition, properties and development.

Flowchart: concept of flow chart, symbols and guide lines, types, Examples: Cartesian to Spherical polar coordinates. Roots of the Quadratic equation, Sum of two matrices, Sum and Product of a finite series, Calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Section B: Scientific Programming: Some fundamental Linux commands (Internal and external commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variables Declaration and concept of instruction and program, Operators: Arithmetic, Relational, Logical, Character and Assignment Expressions Operations, Expressions: Arithmetic, Relational, Logical Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment expressions, Fortran statements, I/O Statements(unformatted/formatted), executable and Non-Executable Statements, Layout of Fortran Program, Format of writing program and concept of coding, Inilisation and Replacement logic, Examples of Physics Problems.

Section C: Control Statements: Types of Logic (Sequential, Selection, Repetition) Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, Selected Case and ELSE IF Ladder Statements), Looping Statements (DO-CONTINUE, DO-END DO,DO-WHILE, Implied and Nested DO Loops), Jumping Statements(Unconditional GOTO, Computed GOTO, Assigned GOTO), Subscripted Variables(Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines(arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O statements, Open a file, Writing in a file, Reading from a file, Examples from Physics problems.

Programming:

1. Exercises on syntax on usage of FORTRAN.
2. To print out all natural even/odd numbers between given limits.
3. To find maximum, minimum and range of a given set of numbers.
4. To find a set of prime numbers and Fibonacci series.

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77, V.Rajaraman (Publisher:PHI)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S. Lipsdutz and A.Poe, 1986 Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi (1999)
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

DSE III Project, Credits – 2, Full Marks – 25

PHYSICS DSE IV: PROJECT / DISSERTATION

Credits: 06, Full Marks - 100

Physics CC XIII: Electromagnetic Theory

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit1: Maxwells Equations: Maxwell Equations, Displacement Current, Vector and Scalar Potentials, Gauge Transformations,Lorentz nd Coulomb Gauge, Boundary Conditions at Interface between Different Media, Wave Equations, Plane Waves in Dielectric Media, Poynting Theorem and Poynting Vector, Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.

Unit II: EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance.

Propagation through conducting media, relaxation time, skin depth. Electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionsphere.

Unit III: EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media- Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular and parallel polarization cases, Brewster's Law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal incidence).

Optical Fibers:- Numerical Aperture, Step and graded indices (Definition only). Single and Multiple mode Fibers (Concept and Definition only).

Unit IV: Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic media. Symmetric nature of dielectric tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light propagation in Uniaxial Crystal. Double Refraction . Polarization by Double Refraction. Nicol Prism. Ordinary and Extraordinary refractive indices. Production & detection of Plane , Circularly and Elliptically Polarized Light.

Unit V: Phase Retardation Plates: Quarter Wave and Half Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light**.**

Rotatory Polarization: Optical Rotation. Biot's Law for Rotatory Polarization. Fresnel's Theory of Optical Rotation. Experimental Verifications of Fresnel's Theory. Specific Rotation. Laurent's Half – shade Polarimeter.

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetic, M.N.O. Sadiku,20001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning.
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill

- Electromanetic Field Theory, R.S Kshetrimayun,2012 , Cengage Learning
- Electromagnetic Field Theory for Engineers and Physicists, G. Lehner, 2010, Springer
- Electricity and Magnetism—D.C. Tayal (Himalaya Publication) 2014
- Introduction to Electrodynamics—A.Z. Capri & P.V. Panat (Alpha Science) 2002

Additional Books for Reference:

- Electromagnetic Field and Waves, P. Lorrain & D. Corson
- Electromagnetics, J.A. Edminster, Schaum series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B.Guru and H. Hiziroglu, 2004, Cambridge University Press.
- Electromagnetic Theory-A.Murthy(S.Chand Publication) 2014
- Classical Electrodynamics,J.D. Jackson(Wiley India)
- Electromagnetic theory & Electrodynamics:Satyaprakash(Kedarnath Ramnath, Meerut/Delhi)
- Concepts of Electromagnetic Theory:Amit Sarin (Kalyani Publisher)

PHYSICS PRACTICAL- CC XIII LAB: ELECTROMAGNETIC THEORY

20Classes , Marks - 25, (2Hr duration)

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyse elliptically polarized light by using a Babinet's Compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid(Kerosine Oil,Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves.
7. To study Polarisation and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air film.
9. To determine the refractive index of (1)glass and (2) a liquid by total internal reflection using a Gussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air glass interface.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.
13. Study of Gaussian nature of Laser beam and measurement Gaussian width

Reference Books:

- Advanced Practical Physics for students,B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Electromagnetic Field Theory for Engineers & Physicist, G.Lehner, 2010, Springer.

Physics CC XIV: Statistical Mechanics

(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Classical Statistics: Macrostate & microstate, Elementary Concept of Ensembles, Microcanonical, Canonical and Grand canonical ensamble, Phase space, Entropy and thermodynamic Probability, Maxwell –Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox,

Unit II: Sackur Tetrode equation, Law of Equipartition of Energy (with proof)- Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temparature.

Unit III: Radiation: Properties of Themal Radiation. Blackbody Radiation. Pure temperature dependence, Kirchhof's law, Stefan-Boltzmann law, Thermodynamic proof, Radiation Pressure, Wein's Displacement law, Saha's Ionization Formula, Rayleigh-Jean's Law.

Unit IV: Ultraviolet Catastrophe. Plank's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) wein's Distribution Law, (3) Stefan's-Boltzmann Law, (4) Wein's displacement law from Planck's law.

Unit V: Quantum Statistics: Identical particles, macrostates and microstates, Fermions and Bosons, Bose Einstein distribution function and Fermi-Dirac Distribution function. Bose-Einstein Condensation, Bose Deviation from Plank's Law. Effect of temperature on F-D distribution function, degenerate fermigas, Density of States, Fermi energy.

Reference Books:

- Statistical Mechanics-R.K. Path & Paul D. Beale (Academic Press) 3rd Edition (2011).
- Statistical Physics, Berkeley Physics Course, F.Reif, 2008, Tata McGraw –Hill.
- Statistical and thermal Physics, S.Lokanathan and R.S. Gambhir, 1991, Prentice Hall.
- Thermodynamics, Kinetic Theory and Statistical thermodynamics, Franscis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford University Press.
- An Introduction to Equilibrium Statistical Mechanics: Palash Das (I.K. International Publication) 2012.
- Statistical Physics-F.Mandl (CBS) 2012
- Statistical Physics of Particles-M.Kardar (Cup 2007)
- Statistical Mechanics: Gupta Kumar (Pragati Prakashan)
- Statistical Mechanics & Solid State Physics: Satyaprakash (Pragati Prakashan)
- Statistical Mechanics: Satyaprakash (Kedar Nath Ram Nath)

PHYSICS PRACTICAL- CC XIV LAB: STATISTICAL MECHANICS
Marks -25, Credit-02

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's Law for Black Body Radiation and compare it with Wien's Law and Raleigh-Jeans Law at high temperature(room temperature) and low temperature.
2. Plot Specific Heat of solids by comparing (a) Dulong-Petit's Law,(b) Einstein's Distribution function,(c) Debye distribution function for high temperature(room temperature) and low temperature and compare them for these two cases.
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Enstein distriburion function versustemperature.

Reference Books:

- Elementary Numerical Analysis, K.E. Atkinson,3rd Edn., 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathira, Butterworth Heinmann: 2nd Ed, 1996, Oxford University Press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich,2009, Springer.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P.Saucez,C.V. Fernandez, 2014v Springer ISBN:978-3319067896
- Scilab by Example: M. Affouf, 2012. ISBN:978-1479203444
- Scilab Image Processing: L.M. Surhone. 2010, Betascript Pub., ISBN: 978-6133459274.