NAAC grade 'A'
KCG grade 'A'

ACADEMIC REGULATIONS

&

SYLLABUS

Faculty of Applied Sciences

Dual Degree (B.Sc.+M.Sc.) Programme Physical Sciences

Year

2016-2017

Charotar University of Science and Technology (CHARUSAT)

CHARUSAT Campus, At Post: Changa – 388421, Taluka: Petlad, District: Anand

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Education Campus – Changa, (ECC), hitherto a conglomerate of institutes of professional education in Engineering, Pharmacy, Computer Applications, Management, Applied Sciences, Physiotherapy and Nursing, is one of the choicest destinations by students. It has been transformed into **Charotar University of Science and Technology (CHARUSAT)** through an Act by Government of Gujarat. CHARUSAT is permitted to grant degrees under Section-22 of UGC-Govt. of India.

The journey of CHARUSAT started in the year 2000, with only 240 Students, 4 Programmes, one Institute and an investment of about Rs.3 Crores (INR 30 million). At present there are seven different institutes falling under ambit of six different faculties. The programmes offered by these faculties range from undergraduate (UG) to Ph.D. degrees. These faculties, in all offer 64 different programmes. A quick glimpse in as under:

Faculty	Institute	Programmes Offered
Faculty of Technology & Engineering	Charotar Institute of Technology	B. Tech M. Tech MTM Ph. D
Faculty of Pharmacy	RamanbhaiPatelCollege of Pharmacy	B. Pharm M. Pharm MPM PGDCT/ PGDPT Ph. D
Faculty of Management Studies	IndukakaIpcowala Institute of Management	M.B.A PGDM Dual Degree BBA+MBA Ph.D
Faculty of Computer Applications	Smt. ChandabenMohanbhai Patel Institute of Computer Applications	M.C.A/MCAL M.Sc (IT) Dual Degree BCA+MCA Ph. D

Faculty of Applied Sciences	P.D.Patel Institute of Applied Sciences	M.Sc Dual Degree B.Sc+M.Sc Ph.D
Faculty of Medical Sciences	Ashok and Rita Institute of Physiotherapy ManikakaTopawala Institute of Nursing Charotar Institute of Paramedical Sciences	B.PT M.PT Ph.D B.Sc (Nursing) M.Sc PGDHA PGDMLT GNM Ph.D

The development and growth of the institutes have already led to an investment of over Rs.125 Crores (INR 1250 Million). The future outlay is planned with an estimate of Rs.250 Crores (INR 2500 Million).

The University is characterized by state-of-the-art infrastructural facilities, innovative teaching methods and highly learned faculty members. The University Campus sprawls over 105 acres of land and is Wi-Fi enabled. It is also recognized as the Greenest Campus of Gujarat.

CHARUSAT is privileged to have 360 core faculty members, educated and trained in IITs, IIMs and leading Indian Universities, and with long exposure to industry. It is also proud of its past students who are employed in prestigious national and multinational corporations.

From one college to the level of a forward-looking University, **CHARUSAT** has the vision of entering the club of premier Universities initially in the country and then globally. **High Moral Values like Honesty, Integrity and Transparency** which has been the foundation of ECC continues to anchor the functioning of **CHARUSAT**. Banking on the world class infrastructure and highly qualified and competent faculty, the University is expected to be catapulted into top 20 Universities in the coming five years. In order to align with the global requirements, the University has collaborated with internationally reputed organizations like Pennsylvania State University – USA, University at Alabama at Birmingham – USA, Northwick Park Institute –UK, ISRO, BARC, etc.

CHARUSAT has designed curricula for all its programmes in line with the current international practices and emerging requirements. Industrial Visits, Study Tours, Expert Lectures and Interactive IT enabled Teaching Practice form an integral part of the unique **CHARUSAT** pedagogy.

The programmes are credit-based and have continuous evaluation as an important feature. The pedagogy is student-centred, augurs well for self-learning and motivation for enquiry and research, and contains innumerable unique features like:

- Participatory and interactive discussion-based classes.
- Sessions by visiting faculty members drawn from leading academic institutions and industry.
- Regular weekly seminars.
- Distinguished lecture series.
- Practical, field-based projects and assignments.
- Summer training in leading organizations under faculty supervision in relevant programmes.
- Industrial tours and visits.
- Extensive use of technology for learning.
- Final Placement through campus interviews.

Exploration in the field of knowledge through research and development and comprehensive industrial linkages will be a hallmark of the University, which will mould the students for global assignments through technology-based knowledge and critical skills.

The evaluation of the student is based on grading system. A student has to pursue his/her programme with diligence for scoring a good Cumulative Grade Point Average (CGPA) and for succeeding in the chosen profession and life.

CHARUSAT welcomes you for a Bright Future

CHARUSAT

FACULTY OF APPLIED SCIENCES

[Bachelor's degree (B.Sc.) component of the Dual degree (B.Sc.+M.Sc.) programme in Physical Sciences]

Highlights of the syllabus of B.Sc. (Physics) and B.Sc. Honours (Physics) in Dual degree (B.Sc.+M.Sc.) program of Physical Sciences for the academic year 2016-17

1. The course is designed in Choice Based Credit System (CBCS)
2. These courses are of three years duration, but receives more credits than regular BSC courses, i.e. instead of 120 credit students have to take 124 credits for B.Sc. Physics and 140 credits for B.Sc. Honours with Physics
3. The course comprises of:
    A. Core courses
    B. Ability Enhancement Compulsory Course
    C. Ability Enhancement Compulsory Course Elective Course
    D. Discipline specific subjects
    E. Interdisciplinary or Generic Elective Course
4. The highly structured program enables foundation to broad understanding of physics principles in wide range of topics, strong mathematical and analytical skills, good laboratory skills and knowledge of computer use and programming at a scientific level
5. The course on skill enhancement is first of its kind in Science undergraduate.
6. Students have freedom to choose advanced courses from more than one discipline to achieve interdisciplinary expertise
7. Exhaustive choice of elective courses to give the student an introduction to more specialized topics in the advanced physics based on students interest and inclination
8. Research Project in the 3rd Year which gives glimpse into possible career research directions
9. Advanced Laboratories to give the student the opportunity to apply the knowledge they gained in the core courses to understand real and important physical phenomena and the use of modern equipment.

10. Open-ended experimental modules to encourage research-based learning techniques
11. Emphasis on applications in solving problems of interest to physicists and evaluation is on the basis of problems seen and unseen

CHARUSAT

FACULTY OF APPLIED SCIENCES

ACADEMIC RULES AND REGULATIONS

The following are the academic rules and regulations for the **under graduate programmes in Physical Sciences** wherein the duration of the course, eligibility criteria and mode of admission, credit requirement and system of examination and other related aspects are laid down.

1. Nomenclature of the degree

The programme shall be called Bachelor of Science **B.Sc. (Physics) and B.Sc. Honours (Physics)**

2. System of Education

- The Semester system and choice based credit system of education shall be followed.
- Duration of each semester will be of at least 90 teaching days.
- Every student requires to do a specified course work in the chosen program of specialization and also to complete project/dissertation/industrial training/specialized training if any.
- **Medium of instruction will be English**

3. ***Duration of Programme***

Undergraduate programme (B.Sc.) 6 semesters (3 academic years)

4. ***Eligibility for admission***

For the admission to B Sc programs in Physical Sciences, a candidate must have successfully passed the higher secondary examination with science subjects from a state or central or international school education boards etc.

5. Mode of admissions

Admission to B Sc programme will be based on merit.

6. Course structure

A student admitted to the program should study the prescribed courses and earn credits specified in the course structure. Courses in a programme will be of three kinds: (1) Core Courses, (2) Elective Courses and (3) Ability Enhancement Courses

(a) **Core courses**: These are the courses which should compulsorily be studied by a candidate and are called "Core compulsory". This category also includes laboratory courses.

(b) **Elective Courses**: These are the courses where choice or an option for the candidate is available. The student can choose the courses from the sister/allied disciplines which supports the main discipline.

(c) **Ability Enhancement Courses**: These are the courses based upon the content that leads to knowledge enhancement and/or skill enhancement. These are mandatory for all disciplines but choices are available to the candidate from the defined courses.

The fourteen core Course papers and the Ability Enhancement Courses are compulsory subjects to study thorough out six semesters. In the category of elective courses, there are two sections, discipline specific electives (DSE) and generic or interdisciplinary elective (GE). The generic electives courses shall be offered during semester one to four. **The course on generic electives shall have a choice and can select four papers of any one discipline or two papers each from any two disciplines to gain 24 credits.** Discipline specific subjects shall cover interdisciplinary subjects to the advanced elective courses to provide students the opportunity to further their knowledge in specific areas and shall choose in the fifth and six semesters. The ability enhancement compulsory courses as English and Environmental sciences are compulsory courses and choice will be given to Skill Enhancement Courses.

The first and second year (up to four semesters) course remains same for both the sections with core courses, generic electives, ability enhancement courses and skill enhancement courses. After 2nd year based on the following criterion students shall be promoted to 3rd Year (fifth and sixth semester) with B.Sc. Physics and B.Sc. Honours with Physics.

Criterion to offer B.Sc. Honours with Physics:

1. All subjects up to 4th semester should be cleared without a FF grade
2. At the end of 2nd Year the CGPA should be ≥ 7

On the basis of criterion 1 and 2 the student will be selected for B.Sc. Honours with Physics. Others shall go for B.Sc. Physics.

At the end of fourth semester, student opting B.Sc. Physics will have two discipline specific subjects DSSs (4 credit each) and for B.Sc. Honours with Physics will be offered an additional 16 credits through discipline specific electives and Research project. The goal of giving Research Project is to expose students to the present research practices, literature reviews, use of advanced techniques, data collection & analysis and to scientific writing and presentation. This will develop the technical, analytical and cognitive skills necessary to pursue a career in scientific research. In addition, visit to scientific labs of national repute shall be arranged every semester as per the need and resources. This is meant to make aware the latest research and technology in the science and to give glimpse of advanced research laboratories.

Credit scheme:

- In order to obtain B.Sc. degree, student should earn minimum prescribed credits and conditions as mentioned in the teaching scheme
- Since every course is independent and self-contained, some courses may be permitted to be registered by the students of other departments; enabling Intra and Inter- disciplinary mobility of the students.
- **The student has to register for the courses as per the teaching scheme to earn minimum credits every semester.**
- A candidate may avail a maximum of two blank semesters in one stretch. However, he has to pay a nominal fee for maintaining a blank semester as decided by the university.

7. *Attendance*

- All activities prescribed under these regulations and listed by the course faculty members in their respective course outlines are compulsory for all students pursuing the courses.
- Minimum attendance is 80%.

8. *Course Evaluation*

The performance of every student in each course will be evaluated as follows:

- Internal evaluation by the course faculty member(s) based on continuous assessment for 30% of the marks for the course; and Final examination 70% of the marks for the course.
- Internal evaluation for theory and practical will be based on Unit tests and several other tools of assessment like quiz, tutorials, seminar, assignments,

day to day laboratory work, journal, viva etc., as prescribed by the concerned teacher and decided by the Faculty of Applied Sciences (See annexure 1 an 2).

- The end examination for 70% of the evaluation for the course will be through written paper or practical test or oral test or presentation by the student or a combination of any two or more of the above.

  - In order to earn the credit in a course a student has to obtain grade other than FF.

Evaluation Scheme

- Continuous and Comprehensive assessment is an integral part of CBCS of CHARUSAT. A continuous assessment system in semester system (also known as internal assessment/comprehensive assessment) is spread through the duration of course and is done by the teacher(s) teaching the course.
- The assessment is done through various means including: Written tests, MCQ based quizzes, Presentations, Mini-projects, Projects, dissertation, Field visits, industry visits, Seminars, assignments, group discussions/activities, Viva-voce etc.
- In “Continuous evaluation” of practical’s students shall be evaluated in a continuous manner for their involvement in the practical, aptitude for learning, completion of practical related assignments, regularity in the laboratory and record keeping.
- The candidate who cannot clear the course has to reregister for the course (crash course/regular course), as and when it is offered by paying prescribed course and examination fees.

9. Grading

Grading Scheme: Relative grading based on ten point scale will be adopted.

Letter Grade	**AA**	**AB**	**BB**	**BC**	**CC**	**CD**	**DD**	**FF**
Grade Point	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**0**

- The student’s performance in any semester will be assessed by the Semester Grade Point Average (SGPA). Similarly, his performance at the end of two or more consecutive semesters will be denoted by the Cumulative Grade Point Average (CGPA). The SGPA and CGPA are calculated as follows:

(i) SGPA = $\sum C_iG_i / \sum C_i$ where C_i is the number of credits of course i

G_i is the Grade Point for the course i and i = 1 to n,

n = number of courses in the semester

(ii) CGPA = $\sum C_iG_i / \sum C_i$ where C_i is the number of credits of course i

G_i is the Grade Point for the course I and i = 1 to n, n = number of courses of all semesters up to which CGPA is computed.

(iii) In addition the student has to complete the required formalities as per the regulatory bodies.

10. Grading Procedure

The committee will be constituted for finalising the Grading.

1. Provost Nominee,
2. Dean
3. Expert Member(s)

11. Awards of Degree

Every student will be eligible for the award of the degree if she/he **should have earned minimum required credits** as prescribed in a program.

12. Provision for Appeal

There shall be a provision for Appeal for a candidate who may be dissatisfied with the Grade he/she has been awarded. He/she can approach the University with the written submission.

13. Award of Class

The class awarded to a student in the programme is decided by the final CGPA as per the following scheme:

CGPA	CLASS
Less than 5.0	Successfully completed
5.00 and Less than 6.00	Second Class
6.00 and Less than 7.50	First class
7.50 and above	First Class with Distinction

14. Transcript

The transcript will be issued to the student only after successful completion of the course by earning required number of credits for B.Sc. or M.Sc. degree. Transcript will contain a consolidated record of all the courses taken, credits earned, grades obtained, SGPA, CGPA, class obtained, etc.

B.Sc. Physics

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English/ Environmental Science	2
	Core course-I	Mathematical Physics-I	4
	Core Course-I Practical/Tutorial	Mathematical Physics-I Lab	2
	Core course-II	Mechanics	4
	Core Course-II Practical/Tutorial	Mechanics Lab	2
	Generic Elective -1	GE-1	4
	Generic Elective -1 Practical/Tutorial		2
II	Ability Enhancement Compulsory Course-II	English/Environmental Science	2
	Core course-III	Electricity and Magnetism	4
	Core Course-III Practical/Tutorial	Electricity and Magnetism Lab	2
	Core course-IV	Waves and Optics	4
	Core Course-IV Practical/Tutorial	Waves and Optics Lab	2
	Generic Elective -2	GE-2	4
	Generic Elective -2 Practical/Tutorial		2
III	Core course-V	Mathematical Physics-II	4
	Core Course-V Practical/Tutorial	Mathematical Physics-II Lab	2
	Core course-VI	Thermal Physics	4
	Core Course-VI Practical/Tutorial	Thermal Physics Lab	2
	Core course-VII	Digital Systems and Applications	4
	Core Course-VII Practical/Tutorial	Digital Systems & Applications Lab	2
	Skill Enhancement Course -1	SEC-1	2
	Generic Elective -3	GE-3	4
	Generic Elective -3 Practical/Tutorial		2
IV	Core course-VIII	Mathematical Physics III	4
	Course-VIII Practical/Tutorial	Mathematical Physics-III Lab	2
	Core course-IX	Elements of Modern Physics	4
	Course-IX Practical/Tutorial	Elements of Modern Physics Lab	2
	Core course-X	Analog Systems and Applications	4
	Course- X Practical/Tutorial	Analog Systems & Applications Lab	2
	Skill Enhancement Course -2	SEC -2	2
	Generic Elective -4	GE-4	4
	Generic Elective -4 Practical		2
V	Core course-XI	Quantum Mechanics & Applications	4
	Core Course-XI Practical/Tutorial	Quantum Mechanics Lab	2
	Core course-XII	Solid State Physics	4
	Core Course-XII Practical/Tutorial	Solid State Physics Lab	2
	Discipline Specific Subject -1	DSE-1	4
VI	Core course-XIII	Electro-magnetic Theory	4
	Core Course-XIII Practical/Tutorial	Electro-magnetic Theory Lab	2
	Core course-XIV	Statistical Mechanics	4
	Core Course-XIV Practical/Tutorial	Statistical Mechanics Lab	2
	Discipline Specific Subject -2	DSE-2	4
Total Credits			124

B.Sc. Honours with Physics

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English/ Environmental Science	2
	Core course-I	Mathematical Physics-I	4
	Core Course-I Practical/Tutorial	Mathematical Physics-I Lab	2
	Core course-II	Mechanics	4
	Core Course-II Practical/Tutorial	Mechanics Lab	2
	Generic Elective -1	GE-1	4
	Generic Elective -1 Practical/Tutorial		2
II	Ability Enhancement Compulsory Course-II	English/ Environmental Science	2
	Core course-III	Electricity and Magnetism	4
	Core Course-III Practical/Tutorial	Electricity and Magnetism Lab	2
	Core course-IV	Waves and Optics	4
	Core Course-IV Practical/Tutorial	Waves and Optics Lab	2
	Generic Elective -2	GE-2	4
	Generic Elective -2 Practical/Tutorial		2
III	Core course-V	Mathematical Physics-II	4
	Core Course-V Practical/Tutorial	Mathematical Physics-II Lab	2
	Core course-VI	Thermal Physics	4
	Core Course-VI Practical/Tutorial	Thermal Physics Lab	2
	Core course-VII	Digital Systems and Applications	4
	Core Course-VII Practical/Tutorial	Digital Systems & Applications Lab	2
	Skill Enhancement Course -1	SEC-1	2
	Generic Elective -3	GE-3	4
	Generic Elective -3 Practical/Tutorial		2
IV	Core course-VIII	Mathematical Physics III	4
	Course-VIII Practical/Tutorial	Mathematical Physics-III Lab	2
	Core course-IX	Elements of Modern Physics	4
	Course-IX Practical/Tutorial	Elements of Modern Physics Lab	2
	Core course-X	Analog Systems and Applications	4
	Course- X Practical/Tutorial	Analog Systems & Applications Lab	2
	Skill Enhancement Course -2	SEC -2	2
	Generic Elective -4	GE-4	4
	Generic Elective -4 Practical		2
V	Core course-XI	Quantum Mechanics & Applications	4
	Core Course-XI Practical/Tutorial	Quantum Mechanics Lab	2
	Core course-XII	Solid State Physics	4
	Core Course-XII Practical/Tutorial	Solid State Physics Lab	2
	Discipline Specific Subject -1	DSS-1	4
	Discipline Specific Subject -2	DSS-2	4
	Research Methodology		2
VI	Core course-XIII	Electro-magnetic Theory	4
	Core Course-XIII Practical/Tutorial	Electro-magnetic Theory Lab	2
	Core course-XIV	Statistical Mechanics	4
	Core Course-XIV Practical/Tutorial	Statistical Mechanics Lab	2
	Discipline Specific Subject -3	DSS-3	4
	Discipline Specific Subject -4	DSS-4	4
	Research Project	RP	6
Total Credits			140

Core Papers (C): (Credit: 06 each) (1 period/week for tutorials or 4 periods/week for practical)

1. Mathematical Physics-I (4 + 4)
2. Mechanics (4 + 4)
3. Electricity and Magnetism (4 + 4)
4. Waves and Optics (4 + 4)
5. Mathematical Physics-II (4 + 4)
6. Thermal Physics (4 + 4)
7. Digital Systems and Applications (4 + 4)
8. Mathematical Physics III (4 + 4)
9. Elements of Modern Physics (4 + 4)
10. Analog Systems and Applications (4 + 4)
11. Quantum Mechanics and Applications (4 + 4)
12. Solid State Physics (4 + 4)
13. Electromagnetic Theory (4 + 4)
14. Statistical Mechanics (4 + 4)

Discipline Specific Subjects DSS: (Credit: 04 each)*

1. Experimental Techniques (4)
2. Analytical Techniques (4)
3. Numerical Analysis (4)
4. Physics of Devices (4)
5. Advanced Mathematical Physics-I (4)
6. Advanced Mathematical Physics-II (4)
7. Classical Dynamics (4)
8. Applied Dynamics (4)
9. Nuclear and Particle Physics (4)
10. Nano Materials and Applications (4)
11. Medical Physics (4)
12. Biological Physics (4)
13. Mini Project (Research base)
14. Research Project
15. Research methodology

Other Discipline/Generic Electives GE (Credit: 06 each) *

1. Astronomy and Astrophysics (4) + Lab (4)
2. Chemistry (4) + Lab (4)
3. Computer Science (4) + Lab (4)
4. Economics (4) + Lab (4)
5. Management (4) + Lab (4)
6. Statistics (4) + Lab (4)

Skill Enhancement Courses SEC (Credit: 02 each)*

1. Workshop Skills
2. Instrumentation Skills
3. Renewable Energy and Energy harvesting
4. Engineering Drawing
5. Radiation Safety

<u>*Note:</u>

I. ***<u>Universities may include more options or delete some from the list of DSS, GE and SEC.</u>***
II. ***<u>The courses to be offered in the DSE, GE and SEC will be defined prior to the start of every semester.</u>***

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY(CHARUSAT)													
Subjects for Dual degree (B.Sc.+M.Sc.) Physics Programme – 2016 Onwards													
Sem	Subject Code	Subjects	Teaching Scheme				Theory Evaluation			Practical Evaluation			Total I+II
			L	P	T	Total Credits	Institute	University	Total-I	Institute	University	Total-II	
Sem I	PD101	Mathematical Physics-I	4	0	0	4	30	70	100	-	-	-	100
	PD102	Mechanics	4	0	1	4	30	70	100	-	-	-	100
	PD103	Mathematical Physics-I Lab	0	4	0	2	-	-	-	15	35	50	50
	PD104	Mechanics Lab	0	4	0	2	-	-	-	15	35	50	50
	CL142	Environmental Sciences	2	0	0	2	30	70	100	-	-	-	100
	HS101E-HS106E	Liberal Arts	0	2	0	2	-	-	-	50	50	100	100
	****	Generic Elective-I	4	2	0	6	30	70	100	50	-	-	150
	Total		14	10	0	22							650

****List of Generic Elective-I

PD105	Three dimensional Geometry
CA171	Computer Fundamentals
PD106	Chemistry-I
PD107	Statistics-I

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY(CHARUSAT)													
Subjects for Dual degree (B.Sc.+M.Sc.) Physics Programme – 2016 Onwards													
Sem	Subject Code	Subjects	Teaching Scheme				Theory Evaluation			Practical Evaluation			Total I+II
			L	P	T	Total Credits	Institute	University	Total-I	Institute	University	Total-II	
Sem II	PD150	Electricity and Magnetism	4	0	1	4	30	70	100	-	-	-	100
	PD151	Waves and Optics	4	0	1	4	30	70	100	-	-	-	100
	PD152	Electricity and Magnetism Lab	0	4	0	2	-	-	-	15	35	50	50
	PD153	Waves and Optics Lab	0	4	0	2	-	-	-	15	35	50	50
	HS121E	English Language and Literature	2	-	0	2	25	25	50	25	25	50	100
	****	Generic Elective -II	4	2	0	6	30	70	100	50	-	-	150
	Total		14	10	0	20							550

****List of Generic Elective-II

PD154	Introduction to positional Astronomy
CA172	Introduction to Database System
PD155	Chemistry-II
PD156	Statistics-II

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY(CHARUSAT)

Subjects for Dual degree (B.Sc.+M.Sc.) Physics Programme – 2016 Onwards

Sem	Subject Code	Subjects	Teaching Scheme				Theory Evaluation			Practical Evaluation			Total I+II
			L	P	T	Total Credits	Institute	University	Total-I	Institute	University	Total-II	
Sem III	PD201	Mathematical Physics-II	4	0	0	4	30	70	100	-	-	-	100
	PD202	Thermal Physics	4	0	0	4	30	70	100	-	-	-	100
	PS203	Digital Systems and applications	4	0	0	4	30	70	100	-	-	-	100
	PD204	Mathematical Physics-II Lab	0	4	0	2	-	-	-	15	35	50	50
	PD205	Thermal Physics Lab	0	4	0	2	-	-	-	15	35	50	50
	PD206	Digital Systems and applications Lab	0	4	0	2	-	-	-	15	35	50	50
	HS131E	Philosophy	2	0	0	2	25	25	50	25	25	50	100
	****	Generic Elective -III	4	2	0	6	30	70	100	50	-	-	150
	****	University Elective	2	0	0	2	30	70	100	-	-	-	100
	Total		20	14	0	28							800

****List of Generic Elective-III

PD207	Introduction to Telescope
CA271	Computer network and internet Technologies
PD208	Chemistry-III
PD209	Statistics-III

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY(CHARUSAT)

Subjects for Dual degree (B.Sc.+M.Sc.) Physics Programme – 2016 Onwards

Sem	Subject Code	Subjects	Teaching Scheme				Theory Evaluation			Practical Evaluation			Total I+II
			L	P	T	Total Credits	Institute	University	Total-I	Institute	University	Total-II	
Sem IV	PD251	Mathematical Physics-III	4	0	0	4	30	70	100				100
	PD252	Elements of Modern physics	4	0	0	4	30	70	100				100
	PD253	Analog Systems and applications	4	0	0	4	30	70	100				100
	PD254	Mathematical Physics-III Lab	0	4	0	2				15	35	50	50
	PD255	Elements of Modern physics Lab	0	4	0	2				15	35	50	50
	PD256	Analog Systems and applications Lab	0	4	0	2				15	35	50	50
	HS123E	Critical Thinking and Logic	2	0	0	2	25	25	50	25	25	50	100
	****	Generic Elective -IV	4	2	0	6	30	70	100	50	-	-	150
	****	University Elective	2	0	0	2	30	70	100	-	-	-	100
	Total		20	14	0	28							800

******List of Generic Elective-IV**

PD257	Galatic Astronomy
CA272	Introduction to Programing
PD258	Chemistry-IV
PD259	Statistics-IV

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY(CHARUSAT)

Subjects for Dual degree (B.Sc.+M.Sc.) Physics Programme – 2016 Onwards

Sem	Subject Code	Subjects	Teaching Scheme				Theory Evaluation			Practical Evaluation			Total I+II
			Lec Hr.	Lab Hr	Tut Hr.	Total Credits	Institute	University	Total-I	Institute	University	Total-II	
Sem V	PD301	Quantum Mechanics and Applications	4		0	4	30	70	100				100
	PD302	Solid State Physics	4		0	4	30	70	100				100
	PD303	Quantum Mechanics Lab		4	0	2				15	35	50	50
	PD304	Solid State Physics Lab		4	0	2				15	35	50	50
	PD3XX	Discipline Specific Subject (DSS) - I	4		0	4	30	70	100				100
	PD3XX	Discipline Specific Subject (DSS) - II	4		0	4				30	70	100	100
	PD3XX	Discipline Specific Subject (DSS) - III	2		0	2	15	35					50
	Total		18	08	0	20							550

PD3XX List of Discipline Specific Subject -V

PD305	Analytical Techniques
PD306	Mini Project (Research base)
PD307	Research Methodology

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY(CHARUSAT)													
Subjects for Dual degree (B.Sc.+M.Sc.) Physics Programme – 2016 Onwards													
Sem	Subject Code	Subjects	Teaching Scheme				Theory Evaluation			Practical Evaluation			Total I+II
			Lec Hr.	Lab Hr	Tut Hr.	Total Credits	Institute	University	Total-I	Institute	University	Total-II	
Sem VI	PD351	Electro-magnetic Theory	4		0	4	30	70	100				100
	PD352	Statistical Mechanics	4		0	4	30	70	100				100
	PD353	Electro-magnetic Theory Lab		4	0	2				15	35	50	50
	PD354	Statistical Mechanics Lab		4	0	2				15	35	50	50
	PD3XX	Discipline Specific Subject (DSS) - IV	4		0	4	30	70	100				100
	PD3XX	Discipline Specific Subject (DSS) - V	4		0	4	30	70	100				100
	PD3XX	Discipline Specific Subject (DSS) - VI		10	0	6				50	150	200	200
	Total		16	18	0	26							700

PD3XX List of Discipline Specific Subject –VI

PD355	Nano Materials and Applications
PD356	Numerical Analysis
PD357	Research Project

Semester –I

PD101 MATHEMATICAL PHYSICS-I

(Credits: 04) **Theory: 60 Lectures**

A. Objective of the course:

- The course is aimed to establish a base for calculus that is largely used in higher learning of physics.
- The course will encompass the basics of functions, differential and integral calculus.
- In addition, the other aspect of the course is that it will introduce the students about the vector calculus**.**
- The emphasis of course is on applications in solving problems of interest to physicists.

B. Outline of the of the course

Content	Time Period
Calculus:	
Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only).	(2 Lectures)
First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.	(13 Lectures)
Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.	(6 Lectures)
Vector Calculus:	
Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.	(5 Lectures)
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.	(8 Lectures)
Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).	(14 Lectures)
Orthogonal Curvilinear Coordinates:	

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.	(6 Lectures)
Introduction to probability:	
Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.	(4 Lectures)
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.	(2 Lectures)

C. Instructional Methods and Pedagogy:

The topics will be discussed in depth in an interactive class room environment using classical black–board teaching method and also power–point presentations will be used at times. Some mathematical calculations will be visualized using computer programs in a full-fledged computer laboratory. Brain storming sessions on various topics will be conducted in order to develop problem solving skills in the students (The students are to be examined on the basis of problems, seen and unseen). Students will be trained to crack national level examinations such as JAM and similar exams. Continuous evaluation process will be adopted by conducting small quizzes, class tests, and seminars which will provide the students an opportunity to improve on their performances.

D. Learning Outcome:

- This course is designed to train the students to understand physics with the help of the tools of mathematics.
- Students will learn how to plot functions with the knowledge of calculus. This will improve the analytical and visualization skills of the students. Moreover, the course will also enlighten the students how to deal with differential equations.
- The importance of differential equations and their wide range of practical applications will enhance the aptitude if the students.
- Finally, this course will indeed build the strong base for the students to move further with physics

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7thEdn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5

Ed., 2012, Jones and Bartlett Learning

- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford Univ. Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press

PD 102 MECHANICS

(Credits: - 04) **Theory: 60 Lectures**

A. Objective of the course:

- The main objective of the course is to introduce basics of Newtonian mechanics, preliminaries of fluid mechanics and fundamentals of special theory of relativity.
- The course is aimed at enhancing the conceptual understanding of fundamentals of classical physics.
- Another aspect of this course is to build the base of the students for understanding of advance level courses of physics.

B. Outline of the course:

Content	Time Period
Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.	(6 Lectures)
Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.	(4 Lectures)
Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.	(3 Lectures)
Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.	(12 Lectures)
Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.	(3 Lectures)
Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.	(2 Lectures)
Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potentialandfield due to spherical shell and solid sphere.	(3 Lectures)
Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	(6 Lectures)
Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation.	(7 Lectures)

Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and QualityFactor.	
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 applications.	(4 Lectures)
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 dilation. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence.	(10Lectures)

C. Instructional Methods and Pedagogy:

The topics will be discussed in depth in an interactive class room environment using classical black–board teaching method and also power–point presentations will be used at times. Brain storming sessions on various topics will be conducted in order to develop problem solving skills in the students. The students are to be examined on the basis of problems, seen and unseen. Students will be trained to crack national level examinations such as JAM and similar exams. Continuous evaluation process will be adopted by conducting small quizzes, class tests, and seminars which will provide the students an opportunity to improve on their performances.

D. Learning outcome:

- The major outcome of the course would be that the students will be well verged with basic mechanics and solving relevant problems.
- The students will be trained to critically think about various day-to-day life activities around them and understand those phenomena using the concepts that they will learn in this course.
- Most importantly, the students will be able to solve any classical physics problem related to this course.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson 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 Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway,2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

D103 MATHEMATICAL PHYSICS-I LAB

(Credits: 02)

A. Objective of the course:

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 physical problems
- The course will consist of lectures (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

B. Outline of the course:

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory andInput/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers,algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflowemphasizethe importance of making equations in termsof dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relativeerrors, Floating point computations.
Review of C & C++ Programmingfundamentals	Introduction to Programming, constants, variables anddata types, operators and Expressions, I/O statements,scanf and printf, c in and c out, Manipulators for dataformatting, Control statements (decision making andlooping statements) (If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator.Goto Statement. Switch Statement. Unconditional andConditional Looping. While Loop. Do-While Loop. FORLoop. Break and Continue Statements. Nested Loops),Arrays (1D & 2D) and strings, user defined functions,Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a list of numbers, largest of a givenlist of numbers and its location in the list, sorting ofnumbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, valueof pi (π)

Solution of Algebraic and Transcendentalequations by Bisection, Newton Raphsonand Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan\alpha\,; I = I_0\left(\frac{\sin\alpha}{\alpha}\right)^2$ in optics
Interpolation by Newton Gregory Forwardand Backward difference formula, Errorestimation of linear interpolation	Evaluation of trigonometric functions e.g. sin θ, cos θ,tan θ, etc.
Numerical differentiation (Forward andBackward difference formula) andIntegration (Trapezoidal and Simpsonrules), Monte Carlo method	Given Position with equidistant time data to calculatevelocity and acceleration and vice versa. Find the area ofB-H Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler,modified Euler and Runge-Kutta (RK)second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton’s law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $\frac{dx}{dt} = y + x - \frac{x^3}{3}\,;\,\frac{dy}{dx} = -x$ for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot x vs y for each of the four initial conditions onthe same screen for $0 \le t \le 15$ The differential equation describing the motion of apendulum is $\frac{d^2\theta}{dt^2} = -\sin(\vartheta)$. The pendulum is releasedfrom rest at an angular displacement α, i. e. $\vartheta(0) = \alpha\ and\ \vartheta'(0) = 0$.Solve the equation for α = 0.1, 0.5and 1.0 and plot ϑas a function of time in the range $0 \le t \le 8\pi$. Also plot the analytic solution valid for small$\vartheta \sin(\vartheta) = \vartheta$

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn. , 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, 3rdEdn., 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher& C. Greif, 2012, PHI Learning.

- Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn. , 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T.Pang, 2ndEdn. , 2006,Cambridge Univ. Press
- Computational Physics, Darren Walker, 1stEdn., 2015, Scientific International Pvt. Ltd.

PD104 MECHANICS LAB

(Credits: -02)

A. Objective of the course:

- Apply experimental methodology to investigate physical phenomena.
- Set up and use laboratory equipment to demonstrate certain aspects of mechanical physics.
- Apply the theory of physics to experimental situations.
- Explain differences between observed and expected results in experiments.

B. Outline of the course:

1. Measurements of length (or diameter) using verniercaliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, AsiaPublishing 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, 11thEdn, 2011, KitabMahal
- Engineering Practical Physics, S.Panigrahi& B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Semester –II

PD150 ELECTRICITY AND MAGNETISM

(Credits:-04) **Theory-60 Lectures**

A. Objective of the course:

- The aim of this course is to establish a grounding in electromagnetism in preparation for more advanced courses

B. Outline of the course:

Electric Field and Electric Potential Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.	**6 Lectures**
Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. Potential and Electric Field of a dipole. Force and Torque on a dipole.	**6 Lectures**
Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere	**10 Lectures**
Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.	8 **Lectures**
Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. 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 current loop in a uniform Magnetic Field.	9 **Lectures**
Magnetic Properties of Matter: Magnetization vector (**M**). Magnetic Intensity (**H**). Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis	**4 Lectures**
Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.	**6 Lectures**
Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.	4 **Lectures**
Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem,	**4 Lectures**

Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.	
Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.	**3 Lectures**

C. Instructional Methods and Pedagogy:

The topics will be discussed in depth in an interactive class room environment using classical black–board teaching method and also power–point presentations will be used at times. Brain storming sessions on various topics will be conducted in order to develop problem solving skills in the students. The students are to be examined on the basis of problems, seen and unseen. Students will be trained to crack national level examinations such as JAM and similar exams. Continuous evaluation process will be adopted by conducting small quizzes, class tests, and seminars which will provide the students an opportunity to improve on their performances.

D. Learning outcome:

Having successfully completed this course, student shall be able to demonstrate knowledge and understanding of:

- the use of Coulomb's law and Gauss' law for the electrostatic force
- the relationship between electrostatic field and electrostatic potential
- the use of the Lorentz force law for the magnetic force
- the use of Ampere's law to calculate magnetic fields
- the use of Faraday's law in induction problems
- the basic laws underlie the properties of electric circuit elements and network theory

E. Referred 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.

PD151 WAVES AND OPTICS

(Credits:-04) **Theory-60 Lectures**

A. Objective of the course:

- to acquire skills allowing the student to identify and apply formulas of optics and wave physics using course literature.
- to be able to identify and illustrate physical concepts and terminology used in optics and to be able to explain them in appropriate detail.
- to be able to make approximate judgements about optical and other wave phenomena when necessary.

B. Outline of the course:

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.	**5 Lectures**
Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.	**3 Lectures**
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.	**5 Lectures**
Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.	**6 Lectures**
Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.	**7 Lectures**
Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.	**4 Lectures**
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.	**9 Lectures**

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.	**6 Lectures**
Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.	**8 Lectures**
Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.	**7 Lectures**

C. Instructional Methods and Pedagogy:

The topics will be discussed in depth in an interactive class room environment using classical black–board teaching method and also power–point presentations will be used at times. Brain storming sessions on various topics will be conducted in order to develop problem solving skills in the students. The students are to be examined on the basis of problems, seen and unseen. Students will be trained to crack national level examinations such as JAM and similar exams. Continuous evaluation process will be adopted by conducting small quizzes, class tests, and seminars which will provide the students an opportunity to improve on their performances.

D. Learning outcome:

- Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical systems
- Understand optical phenomena such as polarisation, birefringence, interference and diffraction in terms of the wave model
- Interference effects; Youngs Slits, Thin film interference, Fabry-Peroy Interferometer

E. 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 Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

PD153 ELECTRICITY AND MAGNETISM LAB

(Credits:-02)

A. Objective of the course:

- Set up and use laboratory equipment to demonstrate certain aspects of electricity and magnetism
- Apply the theory of electricity and magnetism to experimental situations

B. Outline of the course:

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 a solenoid (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.

C. 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
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

PD153 WAVES AND OPTICS LAB

(Credits:-02)

A. Objective of the course:

- to acquire skills allowing the student to identify and apply formulas of optics and wave physics.
- to be able to identify and illustrate physical concepts and terminology used in optics and to be able to explain them in appropriate detail.
- to be able to make approximate judgements about optical and other wave phenomena when necessary.
- to acquire skills allowing the student to organise and plan simpler laboratory course experiments and to prepare an associated oral and written report.

B. Outline of the course:

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 refractive index of the Material of a 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 the 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.

C. 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 undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Semester-III

PD201 MATHEMATICAL PHYSICS-II

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

- The objective of the course is to introduce students to various mathematical methods useful in physics.
- To provide problem solving techniques using these mathematical methods

B. Outline of the course:

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (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. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.	**10 Lectures**
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, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x))and Orthogonality.	**24 Lectures**
Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).	**4 Lectures**
Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line.	**6 Lectures**
Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.	**14 Lectures**

C. Instructional Methods and Pedagogy:

The topics will be discussed in depth in an interactive class room environment using classical black–board teaching method and also power–point presentations will be used at times. Some mathematical calculations will be visualized using computer programs in a full-fledged computer laboratory. Brain storming sessions on various topics will be conducted in order to develop problem solving skills in the students. Students will be trained to crack national level examinations such as JAM, and similar exams of DRDO, and BARC. Continuous evaluation process will be adopted by conducting small quizzes, class tests, and seminars which will provide the students an opportunity to improve on their performances.

D. Student Learning Outcomes:

- This course is aimed at providing students with the mathematical concepts and tools needed to understand crucial concepts of various branches of physics.
- At the end of the course the students would be able to apply the mathematical methods to solve the problems of physics conceptually.
- The training that the student would gain will be useful in developing analytical and interpretation skills by correlating mathematical methods to various physics problems.
- At the long run the training provided will impact the students highly in qualifying the national level exams for further career

E. 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.
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

PD202 THERMAL PHYSICS

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

The objective of this course is to develop a working knowledge of the laws and methods of thermodynamics and elementary statistical mechanics and to use this knowledge to explore various applications. Many of these applications will relate to topics in materials science and the physics of condensed matter.

B. Outline of the course:

Introduction to Thermodynamics **Zeroth and First Law of Thermodynamics**: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.	**8 Lectures**
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 & efficiency. Refrigerator & coefficient of performance, 2^{nd} Law of Thermodynamics: Kelvin-Planck 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.	**10 Lectures**
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. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.	**7 Lectures**
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, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations	**7 Lectures**
Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5)Energy equations, (6) Change of Temperature during Adiabatic Process.	**7 Lectures**
Kinetic Theory of Gases **Distribution of Velocities**: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and	**7 Lectures**

Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.	
Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.	**4 Lectures**
Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. 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 Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.	**10 Lectures**

C. Instructional Methods and Pedagogy:

The topics will be discussed in depth in an interactive class room environment using classical black–board teaching method and also power–point presentations will be used at times. Brain storming sessions on various topics will be conducted in order to develop problem solving skills in the students. The students are to be examined on the basis of problems, seen and unseen. Students will be trained to crack national level examinations such as JAM and similar exams. Continuous evaluation process will be adopted by conducting small quizzes, class tests, and seminars which will provide the students an opportunity to improve on their performances.

D. Student Learning Outcomes:

On successful completion of the course students will be able to:

- Apply thermodynamic theory to real thermodynamic cycles and process and to apply the steady-flow energy equation or the Law of Thermodynamics to a system of thermodynamic components (heaters, coolers, pumps, turbines, pistons, etc.) to estimate required balances of heat, work and energy flow.
- Formulate and solve physics problems through the application of thermodynamics.

E. Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad 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 and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

PD203 DIGITAL SYSTEMS AND APPLICATIONS

(Credits:-04) Theory: 60 Lectures

A. Objective of the course:

- To introduce digital system design, the principles of programmable logic devices, the implementation of combinational and sequential circuits and the introductory understanding of basic microprocessor.

B. Outline of the course:

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.	**3 Lectures**
Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification 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 and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.	**6 Lectures**
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 into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	**6 Lectures**
Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders,Encoders.	**4 Lectures**
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.	**5 Lectures**
Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.	**6 Lectures**
Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.	**3 Lectures**
Shift 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).	**2 Lectures**
Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.	**4 Lectures**
Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.	**6 Lectures**
Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.	**8 Lectures**
Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.	**4 Lectures**

C. Instructional Methods and Pedagogy:

The topics will be discussed in depth in an interactive class room environment using classical black–board teaching method and also power–point presentations will be used at times. Brain storming sessions on various topics will be conducted in order to develop problem solving skills in the students. The students are to be examined on the basis of problems, seen and unseen. Students will be trained to crack national level examinations such as JAM and similar exams. Continuous evaluation process will be adopted by conducting small quizzes, class tests, and seminars which will provide the students an opportunity to improve on their performances.

D. Student Learning Outcomes:

Having successfully completed this course student will be able to:

- Understand the logical behaviour of digital circuits
- Understand the advantages and disadvantages of programmable logic devices
- Design combinational and sequential digital circuits
- Analyse combinational and sequential digital circuits

E. **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 Electronics G K Kharate ,2010, Oxford University Press
- Digital Systems: Principles & 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.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

PD204 MATHEMATICAL PHYSICS-II LAB

(Credits:-02)

A. Outline of the course:

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, Multidimensional 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 program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (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 program (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 (3 meshes) Solution of coupled spring mass systems (3 masses)
Generation of Special functions using User defined functions in Scilab	Generating and plotting Legendre Polynomials Generating and plotting Bessel function
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 • Critical damped • Oscillatory • Forced Harmonic oscillator • Transient and • Steady state solution • Apply above to LCR circuits also • Solve $x^2\frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^2$ with the boundary condition at $x = 1, y = \frac{1}{2}e^2, \frac{dy}{dx} = -\frac{3}{2}e^2 - 0.5$, in the range $1 \le x \le 3$. Plot y and $\frac{dy}{dx}$ against x in the given range on the same graph.
Partial differential equations	Partial Differential Equation: Wave equation Heat equation Poisson equation Laplace equation
Using Scicos / xcos	• Generating square wave, sine wave, saw tooth wave • Solution to harmonic oscillator • Study of beat phenomenon • Phase space plots

A. 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
- Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn. Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014Springer
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- www.**scilab**.in/textbook_companion/generate_book/291

PD205 THERMAL PHYSICSLAB

(Credits:-02)

A. Objective of the course:

1	To determine Mechanical Equivalent of Heat, J, by Callender and Barne'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 Angstrom's Method.
4	To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5	To determine the Temperature Coefficient of 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 specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

B. 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 undergraduate classes,D.P.Khandelwal,1985, Vani Pub.

PD206 DIGITAL SYSTEMS AND APPLICATIONS LAB

(Credits:-02)

A. Objective of the course:

1	To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2	To test a Diode and Transistor using a Multimeter.
3	To design a 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) circuits 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 specifications using 555 Timer.
15	To design a monostable multivibrator of given specifications using 555 Timer.
16	Write the following programs using 8085 Microprocessor a) Addition and subtraction of numbers using direct addressing mode b) Addition and subtraction of numbers using indirect addressing mode c) Multiplication by repeated addition. d) Division by repeated subtraction. e) Handling of 16-bit Numbers. f) Use of CALL and RETURN Instruction. g) Block data handling. h) Other programs (e.g. Parity Check, using interrupts, etc.).

B. Reference Books:

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw 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

PD251 MATHEMATICAL PHYSICS-III

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

- This is a course on advanced methods of mathematical physics. The course aims to demonstrate the utility and limitations of a variety of powerful calculational techniques and to provide a deeper understanding of the mathematics underpinning theoretical physics.
- The course will review and develop the theory of: complex analysis, Integrals Transforms and Laplace Transforms.
- The generality of approaches will be emphasised and illustrative examples from electrodynamics, quantum and statistical mechanics will be given.

B. Outline of the course:

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a 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.	**30 Lectures**
Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.	**15 Lectures**
Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1^{st} order. Solution of heat flow along infinite bar using Laplace transform.	**15 Lectures**

A. 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
- Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press

- Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
- Complex Variables 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, Jones & Bartlett

PD252 ELEMENTS OF MODERN PHYSICS

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

It introduces science students to the foundations and principles of modern physics, such as elementary quantum mechanics and their applications, radioactivity and Laser. The basic objective of this course is to familiarize, the students with the concepts, theories and models behind many applications of our present technological society.

B. Outline of the course:

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.	**14 Lectures**
Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction.	**5 Lectures**
Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.	**10 Lectures**
One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.	**10 Lectures**
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.	**6 Lectures**
Radioactivity: stability of the nucleus; Law of radioactive decay; Mean 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 a nucleus.	**8 Lectures**
Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).	**3 Lectures**

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. Basic lasing.	**4 Lectures**

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.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan

➢ **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, Tata 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.Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

PD253 ANALOG SYSTEMS AND APPLICATIONS

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

- To prepare students to perform the analysis of any Analog electronics circuit.
- To empower students to understand the design and working of Two-terminal Devices and their Applications, BJT amplifiers, oscillators and Operational Amplifier.

B. Outline of the course:

Semiconductor Diodes: P 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. Current Flow Mechanism in Forward and Reverse Biased Diode.	**10 Lectures**
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, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.	**6 Lectures**
Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.	**6 Lectures**
Amplifiers: Transistor Biasing and Stabilization 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.	**10 Lectures**
Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response.	**4 Lectures**
Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.	**4 Lectures**
Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.	**4 Lectures**
Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.	**4 Lectures**
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.	**9 Lectures**

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation)	**3 Lectures**

C. Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 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
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

PD254 MATHEMATICAL PHYSICS-III LAB

(Credits:-02)

A. Outline of the course:

Scilab/C++ based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:
   $dy/dx = e^{-x}$ with $y = 0$ for $x = 0$
   $dy/dx + e^{-x}y = x^2$
   $d^2y/dt^2 + 2\, dy/dt = -y$
   $d^2y/dt^2 + e^{-t}dy/dt = -y$

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 $\boldsymbol{\sigma}$ = 1, 0.1, 0.01 and show it tends 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 $P_n(x)$, $j_\nu(x)$

   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. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.
8. Compute the nth roots of unity for *n* = 2, 3, and 4.
9. Find the two square roots of −5+12*j*.
10. Integral transform: FFT of e^{-x^2}
11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.
12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.
13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

B. 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. Fernández. 2014 Springer ISBN: 978-3319067896
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- https://web.stanford.edu/~boyd/ee102/**laplace**_ckts.pdf
- ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

PD255 ELEMENTS OF MODERN PHYSICS LAB

(Credits:-02)

A. Outline of the course:

1	Measurement of Planck's constant using black body radiation and photo-detector
2	Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of 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 wavelength of laser source using diffraction of single slit.
12	To determine the wavelength of laser source using diffraction of double slits.
13	To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

C. 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 Edn, 2011,Kitab Mahal

PD256 ANALOG SYSTEMS AND APPLICATIONS LAB

(Credits:-02)

A. Outline of the course:

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 use as voltage regulator.
3	Study of V-I & power curves of solar cells, 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 configurations of BJT for normal class A operation.
6	To design a CE transistor amplifier of 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 given frequency using an op-amp.
9	To design a phase shift oscillator of given specifications using BJT.
10	To study the Colpitt`s oscillator.
11	To design a digital to analog converter (DAC) of given specifications.
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 an op-amp as an Integrator.
20	To investigate the use of an op-amp as a Differentiator.
21	To design a circuit to simulate the solution of a 1st/2nd order differential equation.

B. Reference Books:

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

Semester-V

PD301 QUANTUM MECHANICS AND APPLICATIONS

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

- To introduce students to the physics of systems when their dimensions are microscopic.
- To make the students understand how classical physics cannot explain many of the physical phenomena.
- To understand the application of quantum mechanics to real life problems.

B. Outline of the course:

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a 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. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.	**6 Lectures**
Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wave function as a linear combination of energy Eigen functions; General solution of the 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.	**10 Lectures**
General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition 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 using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle.	**12 Lectures**
Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells.	**10 Lectures**
Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.	**8 Lectures**

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).	**4 Lectures**
Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).	**10 Lectures**

C. 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 Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- **Additional Books for Reference**
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

PD302 SOLID STATE PHYSICS

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

- The objective of the course is to introduce students to understand crystallography without necessarily becoming crystallographer.
- To explore the basics of x-ray diffraction and structure analysis.
- To understand basics of lattice dynamics and its related properties.
- To provide problem solving techniques.

B. Outline of the course:

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.	**12 Lectures**
Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law	**10 Lectures**
Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.	**8 Lectures**
Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.	**8 Lectures**
Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.	**6 lectures**
Elementary band theory: Kronig 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 coefficient.	**10 Lectures**
Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)	**6 Lectures**

C. 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-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, 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, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

PD303 QUANTUM MECHANICS AND APPLICATIONS LAB (Credits:-02)

A. Outline of the course:

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:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E] where\ V(r) = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m =0.511x10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{\frac{-r}{a}}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511x10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E] where\ V(r) = -\frac{e^2}{r}$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^2$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{h^2}[V(r) - E]$$

Where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2ar'} - e^{-ar'}), r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
Take: m = 940x10^6eV/C^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

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

B. 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 MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

PD304 SOLID STATE PHYSICS LAB

(Credits:-02)

A. Outline of the course:

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 Constant of a dielectric Materials with frequency
5	To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6	To determine the refractive index of a dielectric layer 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 oC) and to determine its band gap.
10	To determine the Hall coefficient of a semiconductor sample.

A. 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
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Semester: VI

PD351 ELECTROMAGNETIC THEORY

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

- To introduce student to the concepts of charge in static state and what happen ehn charge moves.
- To make the students understand how the laws of physics work for charged particles and matter in electric field.
- To develop the skill of solving complex problems using various techniques.

Outline of the course:

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and 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, Momentum Density and Angular Momentum Density.	**12 Lectures**
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. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.	**10 Lectures**
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 & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)	**10 Lectures**
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 & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light	**12 Lectures**

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter.	**5 Lectures**
Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission	**8 Lectures**
Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).	**3 Lectures**

B. Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, 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
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
- **Additional Books for Reference**
- Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

PD352 STATISTICAL MECHANICS

(Credits:-04) **Theory: 60 Lectures**

A. Objective of the course:

- To introduce students to statistical behavior of physical and chemical phenomena .
- To built a basis for understanding various aspects of condensed matter.
- To develop an understanding towards phase transitions of matter from one form to the other.

B. Outline of the course:

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, 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 Temperature.	**18 Lectures**
Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.	**9 Lectures**
Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.	**5 Lectures**
Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.	**15 Lectures**

C. Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- 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, Francis 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 Univ. Press

PD353 ELECTROMAGNETIC THEORY LAB

(Credits:-02)

A. Outline of the course:

1	To verify the law of Malus for plane polarized light.
2	To determine the specific rotation of sugar solution using Polarimeter.
3	To analyze 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 (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6	To study the reflection, refraction of microwaves
7	To study Polarization 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 Gaussian 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.

A. **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 & Physicists, G. Lehner, 2010, Springer

PD354 STATISTICAL MECHANICS LAB

(Credits:-02)

A. Outline of the course:

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 Wein'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 law, (b) Einstein 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-Einstein distribution function versus temperature.

A. Reference Books:

- Elementary Numerical Analysis, K.E.Atkinson, 3 r d Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 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. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 9786133459274

Discipline Specific Elective Courses

DSE: EXPERIMENTAL TECHNIQUES

(Credits: 04) **Theory: 60 Lectures**

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution.	**7 Lectures**
Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise	**7 Lectures**
Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference.	**4 Lectures**
Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.	**21 Lectures**
Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.	**5 Lectures**
Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.	**4 Lectures**
Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).	**12 Lectures**

A. Reference Books:

- Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
- Experimental Methods for Engineers, J.P. Holman, McGraw Hill

- Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
- Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
- Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
- Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
- Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

DSE: EMBEDDED SYSTEM: INTRODUCTION TO MICROCONTROLLERS

(Credits: 04) **Theory: 60 Lectures**

Embedded system introduction: Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges & design issues in embedded systems, operational and non-operational quality attributes of embedded systems, elemental description of embedded processors and microcontrollers.	**6 Lectures**
Review of microprocessors: Organization of Microprocessor based system, 8085μp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts.	**4 Lectures**
8051 microcontroller: Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.	**12 Lectures**
8051 I/O port programming: Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions, I/O port programming in 8051 (using assembly language), I/O programming: Bit manipulation.	**4 Lectures**
Programming: 8051 addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, arithmetic and logic instructions, 8051 programming in C: for time delay & I/O operations and manipulation, for arithmetic and logic operations, for ASCII and BCD conversions.	**12 Lectures**
Timer and counter programming: Programming 8051 timers, counter programming.	**3 Lectures**
Serial port programming with and without interrupt: Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051.	**6 Lectures**
Interfacing 8051 microcontroller to peripherals: Parallel and serial ADC, DAC interfacing, LCD interfacing.	**2 Lectures**
Programming Embedded Systems: Structure of embedded program, infinite loop, compiling, linking and locating, downloading and debugging.	**3 Lectures**
Embedded system design and development: Embedded system development environment, file types generated after cross compilation, disassembler/ decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry.	**8 Lectures**

A. Reference Books:

- Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill
- The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
- Embedded microcomputor system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole
- Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.
- Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India
- Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

DSE: PHYSICS OF DEVICES AND INSTRUMENTS

(Credits: 04) **Theory: 60 Lectures**

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metalsemiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET–their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.	**15 Lectures**
Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection	**3 Lectures**
Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.	**3 Lectures**
Multivibrators: Astable and Monostable Multivibrators using transistors.	**3 Lectures**
Phase Locked Loop (PLL): Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter–Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).	**5 Lectures**
Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.	**12 Lectures**
Digital Data Communication Standards: Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices(Basic idea of UART). Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.	**4 Lectures**
Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.	**15 lectures**

A. Reference Books:

- Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
- Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
- Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
- Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.

- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

DSE: ADVANCED MATHEMATICAL PHYSICS

(Credits: 04) **Theory: 60 Lectures**

Linear Algebra: Vector Spaces: Vector Spaces over Fields of Real and Complex numbers. Examples. Vector space of functions. Linear independence of vectors. Basis and dimension of a vector space. Change of basis. Subspace. Isomorphisms. Inner product and Norm. Inner product of functions: the weight function. Triangle and Cauchy Schwartz Inequalities. Orthonormal bases. Sine and cosine functions in a Fourier series as an orthonormal basis. Gram Schmidt orthogonalisation.	**12 Lectures**
Linear Transformations: Introduction. Identity and inverse. Singular and non-singular transformations. Representation of linear transformations by matrices. Similarity transformation. Linear operators. Differential operators as linear operators on vector space of functions. Commutator of operators. Orthogonal and unitary operators and their matrix representations. Adjoint of a linear operator. Hermitian operators and their matrix representation. Hermitian differential operators and boundary conditions. Examples. Eigenvalues and eigenvectors of linear operators. Properties of eigenvalues and eigenvectors of Hermitian and unitary operators. Functions of Hermitian operators/ matrices.	**18 Lectures**
Tensors: Tensors as multilinear transformations (functionals) on vectors. Examples: Moment of Inertia, dielectric susceptibility. Components of a tensor in basis. Symmetric and antisymmetric tensors. The completely antisymmetric tensor. Non-orthonormal and reciprocal bases. Summation convention. Inner product of vectors and the metric tensor. Coordinate systems and coordinate basis vectors. Reciprocal coordinate basis. Components of metric in a coordinate basis and association with infinitesimal distance. Change of basis: relation between coordinate basis vectors. Change of tensor components under change of coordinate system. Example: Inertial coordinates & bases in Minkowski space, Lorentz transformations as coordinate transformations, Elelctromagnetic tensor and change in its components under Lorentz transformations.	**18 Lectures**
Calculus of Variations Variational Principle: Euler's Equation. Application to Simple Problems (shape of a soap film, Fermat's Principle, etc.). Several Dependent Variables and Euler's Equations. Example: Hamilton's Principle and the Euler-Lagrange equations of motion. Geodesics: geodesic equation as a set of Euler's equations. Constrained Variations: Variations with constraints. Applications: motion of a simple pendulum, particle constrained to move on a hoop.	**12 Lectures**

A. Reference Books:

- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
- Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
- Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
- Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press

DSE: CLASSICAL DYNAMICS

(Credits: 05) **Theory: 64 Lectures**

Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Poisson brackets. Canonical transformations.	**22 Lectures**
Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, 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 effect from a fourvector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. The Electromagnetic field tensor and its transformation under Lorentz transformations: relation to known transformation properties of **E** and **B**. Electric and magnetic fields due to a uniformly moving charge. Equation of motion of charged particle & Maxwell's equations in tensor form. Motion of charged particles in external electric and magnetic fields.	**38 Lectures**
Electromagnetic radiation: Review of retarded potentials. Potentials due to a moving charge: Lienard Wiechert potentials. Electric & Magnetic fields due to a moving charge: Power radiated, Larmor’s formula and its relativistic generalisation.	**15 Lectures**

A. Reference Books:

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
- Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

DSE: APPLIED DYNAMICS

(Credits: 04) **Theory: 60 Lectures**

Introduction to Dynamical systems: Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Simple mechanical systems as first order dynamical systems : the free particle, particle under uniform gravity, simple and damped harmonic oscillator. Sketching flows and trajectories in phase space; sketching variables as functions of time, relating the equations and pictures to the underlying physical intuition. Other examples of dynamical systems – In Biology: Population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits In Chemistry: Rate equations for chemical reactions e.g. auto catalysis, bistability In Economics: Examples from game theory. Illustrative examples from other disciplines. Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples. Computing and visualizing trajectories on the computer using a software packages. Discrete dynamical systems. The logistic map as an example.	**26 Lectures**
Introduction to Chaos and Fractals: Examples of 2-dimensional billiard, Projection of the trajectory on momentum space. Sinai Billiard and its variants. Computational visualization of trajectories in the Sinai Billiard. Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle. Electron motion in mesoscopic conductors as a chaotic billiard problem. Other examples of chaotic systems; visualization of their trajectories on the computer. Self-similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need for fractal dimension to describe self-similar structure. Deterministic fractal vs. self-similar fractal structure. Fractals in dynamics – Serpinski gasket and DLA. Chaos in nonlinear finite-difference equations- Logistic map: Dynamics from time series. Parameter dependence- steady, periodic and chaos states. Cobweb iteration. Fixed points. Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions. Period- Doubling route to chaos. Nonlinear time series analysis and chaos characterization: Detecting chaos from return map. Power spectrum, autocorrelation, Lyapunov exponent, correlation dimension.	**20 Lectures**
Elementary Fluid Dynamics: Importance of fluids: Fluids in the pure sciences, fluids in technology. Study of fluids: Theoretical approach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: The continuum hypothesisconcept of fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform & non-uniform flows, viscous & inviscid flows, incompressible & compressible flows, laminar and turbulent flows,	**14 Lectu res**

rotational and irrotational flows,separated & unseparated flows. Flow visualization - streamlines, pathlines, Streaklines.	

A. Reference Books:

- Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007
- Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
- An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
- Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1987.

DSE: Nuclear and Particle Physics

(Credits: 05) **Theory: 75 Lectures**

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative 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, magnetic moment, electric moments, nuclear excites states.	**10 Lectures**
Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.	**12 Lectures**
Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c)Gamma decay: Gamma rays emission & kinematics, internal conversion.	**9 Lectures**
Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).	**8 Lectures**
Nuclear Astrophysics: Early universe, primordial nucleosynthesis (particle nuclear interactions), stellar nucleosynthesis, concept of gamow window, heavy element production: r- and s- process path.	**5 Lectures**
Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.	**6 Lectures**
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.	**6 Lectures**
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, concept of quark model, color quantum number and gluons.	**14 Lectures**

A. Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).

- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

DSE: Astronomy & Astrophysics

(Credits: 05) **Theory: 75 Lectures**

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. **Basic concepts of positional astronomy:** Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram.	**22 Lectures**
Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes). **Physical principles:** Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium, Theory of Radiative Transfer (Radiation Field, Radiative Transfer Equation), Optical Depth; Solution of Radiative Transfer Equation, Local Thermodynamic Equilibrium	**6 Lectures**
The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magnetohydrodynamics. Helioseismology). **The solar family** (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets. **Stellar spectra and classification Structure (**Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)	**7 Lectures**
Stellar structure: Hydrostatic Equilibrium of a Star, Some Insight into a Star: Virial Theorem, Sources of Stellar Energy, Modes of Energy Transport, Simple Stellar Model, Polytropic Stellar Model. **Star formation: B**asic composition of Interstellar medium, Interstellar Gas, Interstellar Dust, Formation of Protostar, Jeans criterion, Fragmentation of collapsing clouds, From protostar to Pre-Main Sequence, Hayashi Line.	**8 Lectures**
Nucleosynthesis and stellar evolution: Cosmic Abundances, Stellar Nucleosynthesis, Evolution of Stars (Evolution on the Main	**11 Lectures**

Sequence, Evolution beyond the Main Sequence), Supernovae. **Compact stars:** Basic Familiarity with Compact Stars, Equation of State and Degenerate Gas of Fermions, Theory of White Dwarf, Chandrasekhar Limit, Neutron Star (Gravitational Red-shift of Neutron Star, Detection of Neutron Star: Pulsars), Black Hole. **The milky way**: Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus	
Galaxies: Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms, Active Galaxies	**5 Lectures**
Active galaxies: 'Activities' of Active Galaxies, How 'Active' are the Active Galaxies? Classification of the Active Galaxies, Some Emission Mechanisms Related to the Study of Active Galaxies, Behaviour of Active Galaxies (Quasars and Radio Galaxies, Seyferts, BL Lac Objects and Optically Violent Variables), The Nature of the Central Engine, Unified Model of the Various Active Galaxies	**8 Lectures**
Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance-Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter), Friedmann Equation and its Solutions, Early Universe and Nucleosynthesis (Cosmic Background Radiation, Evolving vs. Steady State Universe)	**8 Lectures**

A. Reference Books:

- Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
- The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
- Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
- K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
- Baidyanath Basu, 'An introduction to Astro physics', Second printing, Prentice - Hall of India Private limited, New Delhi,2001.
- Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

DSE: Atmospheric physics

(Credits: 04) **Theory: 60 Lectures**

General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms.	**12 Lectures**
Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Mesoscale circulations, The general circulations, Tropical dynamics.	**12 Lectures**
Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration	**12 Lectures**
Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques.	**12 Lectures**
Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars.	**12 Lectures**

A. Reference Books:

- Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
- The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3rd edn. 2002.
- An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
- Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

DSE: Nano Materials and Applications

(Credits: 04) **Theory: 60 Lectures**

NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.	**10 Lectures**
SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.	**8 Lectures**
CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.	**8 Lectures**
OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi- articles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures.	**14 Lectures**
ELECTRON TRANSPORT: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.	**6 Lectures**
APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	**14 ectur es**

A. Reference Books:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).

* Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

DSE: Earth Science

(Credits: 05) **Theory: 75 Lectures**

1. **The Earth and the Universe**: (a) Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences. (b) General characteristics and origin of the Universe. The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. (c) Energy and particle fluxes incident on the Earth. (d) The Cosmic Microwave Background.	**17 Lectures**
2. **Structure:** (a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior? (b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems. (c) The Atmosphere: variation of temperature, density and composition with altitude, clouds. (d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers. (e) The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms.	**18 Lectures**
3. **Dynamical Processes**: (a) The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics; sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution. (b) The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes. Tides. Tsunamis. (c) The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones. Climate: i. Earth's temperature and greenhouse effect. ii. Paleoclimate and recent climate changes. iii. The Indian monsoon system. (d) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle. The role of cycles in maintaining a steady state.	**18 Lectures**

4. Evolution: Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent. 1. Time line of major geological and biological events. 2. Origin of life on Earth. 3. Role of the biosphere in shaping the environment. 4. Future of evolution of the Earth and solar system: Death of the Earth.	**18 Lectures**
5. Disturbing the Earth – Contemporary dilemmas (a) Human population growth. (b) Atmosphere: Greenhouse gas emissions, climate change, air pollution. (c) Hydrosphere: Fresh water depletion. (d) Geosphere: Chemical effluents, nuclear waste. (e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.	**4 Lectures**

A. Reference Books:

- Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
- Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
- Holme’s Principles of Physical Geology. 1992. Chapman & Hall.
- Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

DSE: Medical Physics

(Credits: 04) **Theory: 60 Lectures**

PHYSICS OF THE BODY-I **Mechanics of the body:** Skeleton, forces, and body stability. Muscles and the dynamics of body movement, Physics of body crashing. **Energy household of the body:** Energy balance in the body, Energy consumption of the body, Heat losses of the body, **Pressure system of the body:** Physics of breathing, Physics of cardiovascular system.	**10 Lectures**
PHYSICS OF THE BODY-II **Acoustics of the body:** Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. **Optical system of the body:** Physics of the eye. **Electrical system of the body:** Physics of the nervous system, Electrical signals and information transfer.	**10 Lectures**
PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I **X-RAYS:** Electromagnetic spectrum – production of x-rays – x-ray spectra- Brehmsstrahlung- Characteristic x-ray – X-ray tubes – Coolidge tube – x-ray tube design – tube cooling stationary mode – Rotating anode x-ray tube – Tube rating – quality and intensity of x-ray. X-ray generator circuits – half wave and full wave rectification – filament circuit – kilo voltage circuit – high frequency generator – exposure timer – HT cables.	**7 Lectures**
RADIATION PHYSICS: Radiation units - exposure - absorbed dose – units: rad, gray -relative biological effectiveness - effective dose - inverse square law - interaction of radiation with matter - linear attenuation coefficient. Radiation Detectors –Thimble chamber- condenser chambers – Geiger counter – Scintillation counter – ionization chamber – osimeters – survey methods – area monitors – TLD and semiconductor detectors.	**7 Lectures**
MEDICAL IMAGING PHYSICS: X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR) – NMR imaging – MRI Radiological imaging –Radiography – Filters – grids – cassette – X-ray film – film processing – fluoroscopy –computed tomography scanner – principle function – display – generations –mammography. Ultrasound imaging – magnetic resonance imaging – thyroid uptake system – Gamma camera (Only Principle, function and display)	**9 Lectures**
RADIATION THERAPY PHYSICS: Radiotherapy – kilo voltage machines – deep therapy machines – Telecobalt machines – Medical linear accelerator. Basics of Teletherapy units – deep x-ray, Telecobalt units, medical linear accelerator – Radiation protection – external beam characteristics – phantom – dose maximum and build up – bolus – percentage depth dose – tissue – air ratio – back scatter factor.	**6 Lectures**

RADIATION AND RADIATION PROTECTION: Principles of radiation protection– protective materials-radiation effects – somatic, genetic stochastic & deterministic effect, Personal monitoring devices – TLD film badge – pocket dosimeter. Radiation dosimetry, Natural radioactivity, Biological effects of radiation, Radiation monitors**.**	**6 Lectures**
PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-II Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment	**5 Lectures**

A. Reference Books:

- Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
- Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
- Christensen’s Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
- Physics of the human body, Irving P. Herman, Springer (2007).
- Physics of Radiation Therapy : F M Khan - Williams and Wilkins, 3rd edition (2003)
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
- The Physics of Radiology-H E Johns and Cunningham.

DSE: Bio-Physics

(Credits: 05) **Theory: 75 Lectures**

Building Blocks & Structure of Living State: Atoms and ions, molecules essential for life, what is life. **Living state interactions:** Forces and molecular bonds, electric & thermal interactions, electric dipoles, casimir interactions, domains of physics in biology.	**18 Lectures**
Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat equation, Joule heating of tissue. **Living State Thermodynamics:** Thermodynamic equilibrium, fIrst law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics, Physics of many particle systems, Two state systems, continuous energy distribution, Composite systems, Casimir contribution of free energy, Protein folding and unfolding.	**19 Lectures**
Open systems and chemical thermodynamics: Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, The grand canonical ensemble, Hemoglobin. **Diffusion and transport** Maxwell-Boltzmann statistics, Fick's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field, Lateral diffusion in membranes, Navier stokes equation, low Reynold's Number Transport, Active and passive membrane transport.	**19 Lectures**
Fluids: Laminar and turbulent fluid flow, Bernoulli's equation, equation of continuity, venture effect, Fluid dynamics of circulatory systems, capillary action. **Bioenergetics and Molecular motors:** Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorption in biomolecules, vibrational spectra of bio-biomolecules.	**19 Lectures**

A. Reference Books:

- Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers
- Aspects of Biophysics, Hughe S W, John Willy and Sons.
- Essentials of Biophysics by P Narayanan, New Age International

Annexure-I

Policy for distribution of Internal marks

Particulars	**Marks distribution for 2 credit course**	**Marks distribution for 3 or 4 credit course**
All the **Unit test/Quiz, other continuous assessment tool**	15	30
Total	**15**	**30**

Note:

ii. **Internal Exam pattern shall follow the pattern of external examination**

iii. **Minimum two internal tests shall be conducted**

Policy for distribution of External marks

Particulars	**Type**	**Marks distribution for 2 credit course**	**Marks distribution for 3 or 4 credit course**
Quesstion.I	**Multiple choice questions (MCQ)**	10 (Multiple Questions of 1M each)	20 (Multiple Questions of 1M each)
Question :II	**Short answer type questions (SQ)**	10 (2 marks to 3 marks type with sub questions if needed)	20 (2 marks to 3 marks type with sub questions if needed)
Question :III	**Long answer type questions (LQ): Numerical/Problem solving (seen and unseen)**	15 (4 marks to 5 marks type with sub questions if needed)	30 (4 marks to 5 marks type with sub questions if needed)
	Total	**35**	**70**

Note:

i. **The duration for 2 credit (35M) paper shall be of 2 hours and no sectional divisions**

ii. **The duration for 3 to 4 credit (70M) paper shall be of 3 hours and there shall have two sections: Section I (Q.I and Q.II) and Section II (Q.III)**

Annexure-II

Pattern of External Exam

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY

First Semester of B.Sc. (Physics) Examination

December 2016

PD101 Mathematical Physics-I

Date: 12.12.2016, Monday Time: 10:00 a.m. To 01:00 p.m. Maximum Marks: 70

Instructions:
1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.
5. Show necessary diagram and calculations.

SECTION – I		
Q - I	Choose the correct answer for the following questions (MCQ).	**[20]**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		

18.		
19.		
20.		

Q - II	Answer the following questions as directed (Short questions)	**20**
1.		**[2]**
2.		**[2]**
3.		**[2]**
4.		**[2]**
5.		**[2]**
6.		**[2]**
7.		**[2]**
8.		**[3]**
9.		**[3]**
	SECTION – II	
Q-III	Answer the following questions as directed (Long questions)	**30**
1.		**[04]**
2.		**[04]**
3.		**[04]**
4.		**[04]**
5.		**[04]**
6.		**[05]**
7.		**[05]**

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY

First Semester of B.Sc. (Physics) Examination

December 2016

PD101 Mathematical Physics-I

Date: 12.12.2016, Monday Time: 10:00 a.m. To 12:00 a.m. Maximum Marks: 35

Instructions:

1. Make suitable assumptions and draw neat figures wherever required.
2. Use of scientific calculator is allowed.
3. Show necessary diagram and calculations.

SECTION – I		
Q - I	Choose the correct answer for the following questions (MCQ).	**[10]**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Q - II	Answer the following questions as directed (Short questions)	**10**
1.		**[2]**
2.		**[2]**
3.		**[2]**
4.		**[2]**
5.		**[2]**
Q-III	Answer the following questions as directed (Long questions)	**15**
1.		**[03]**
2.		**[04]**
3.		**[04]**

4.		**[04]**