JAIPUR NATIONAL UNIVERSITY

A venture of The Seedling Group of Educational Institutions

Bachelor of Science

B.Sc.-PCM

Mode: Distance

PROGRAM PROJECT REPORT

Contents

B.Sc. - (PCM)

1. Program Overview

1.1 Program's Mission and Objectives

The B.Sc. Pass Course (PCM) program typically refers to a Bachelor of Science degree with a focus on the subjects of Physics, Chemistry, and Mathematics. B.Sc PCM prepares students for higher education in physical, mathematical, and chemical sciences while contributing to societal well-being. The course intends to assist students to comprehend the significance of the chemicals, chemical industry and enhancing human life quality. It also helps academics recognize and appreciate the contributions of outstanding scientists in the fields of physics, chemistry, and mathematics. The objectives of the program are as follows:

i. **PSO1**: Understand the theoretical concepts of physical and chemical properties of materials and the role of mathematics in dealing with them in a quantitative way.

ii. **PSO2**: Analyze the concepts of mathematics, physics and chemistry and understand the relation among them like physical chemistry, mathematical modelling of physics and chemistry problems.

iii. **PSO3**: Skills needed to handle instruments and adopt lab procedures to study physical and chemical properties of materials.

iv. **PSO4**: Mathematical and numerical techniques required to compute the research results.

v. **PSO5**: Ability to interlink the skills and knowledge in mathematics, physics and chemistry and develop an aptitude to address the problems in biophysics, stock market analysis etc.

1.2 Relevance of the Program with JNU's Vision and Mission

Jaipur National University (JNU) was established in 2007. JNU provides a world-class learning experience, with a highly accomplished faculty, numerous extracurricular activities, and a wide range of academic pursuits. The university fosters holistic development of students.

JNU with its vision to transform the Education Landscape of India and contribute to the maximum to improve the GER of India has plans to launch affordable and flexible education programs. Distance programs are an excellent way to launch affordable and flexible education programs in sync with the vision and mission of the university stated below:

University Vision:

To be a leader in creating unique and exclusive learning opportunities in all disciplines of study that ultimately lead to the advancement of learning and creation of a sustainable society and environment.

University Mission:

- Provide global opportunities of learning through broad and balanced academic programmes.
- Explore and hone the potential of stakeholders, develop their human and intellectual capacities to the fullest.
- Create and maintain excellence with high standard driven activities, universal significance and acknowledgement.
- Inculcate and keep track of the current trends and finest practices in education for constant growing and evolving.
- Leverage diversity of thoughts, ideas, and perspectives to enrich the stake holders

1.3 Nature of Prospective Target Group of Students

The curriculum of BSc-PCM is designed in such a way that it helps the students to become not only more employable but also encourage them to become entrepreneurs. Primarily the target group of learners will be:

- Population of any age and those living in remote areas where higher education institutes are not easily accessible.
- Learners who could not get admission in the regular mode due to limited intake capacity.
- Learners who are working and who desire to pursue higher education as a means for movement up the ladder.
- Learners who are unable to pursue Higher education due to social, financial and economic compulsions as well as demographic reasons.

1.4 Appropriateness of programs to be conducted in Distance mode to acquire specific skills and competence

BSc (Pass course)-PCM is tailored to make the students geared up for employment in the relevant industries, develop the culture of research and use these skills in ensuring development of the nation. It also aims to create environmental awareness and sensitivity among students.

2. Procedure for Admission and Curriculum Transaction

The academic programs catered to candidates enrolled in the distance mode of learning are facilitated by CDOE-JNU, with the backing of various faculties within the University. Eligibility criteria, course structure, detailed curriculum, program duration, and evaluation criteria are subject to approval by the Board of Studies and Academic Council, adhering to UGC guidelines for programs falling under the purview of distance mode for degree conferment.

Below are the details of the admission procedure, eligibility criteria, fee structure, curriculum, and program delivery, information about the Learning Management System (LMS), and assessments and evaluations:

2.1 Procedure for Admission

Students who are seeking admission in programs offered by CDOE-JNU need to apply through https://online.jnujaipur.ac.in/ in the courses offered.

2.1.1 Minimum Eligibility Criteria for Admission

The minimum eligibility criteria for admission to the distance B.Sc.-PCM program require candidates to 10+2 (12^{th} Standard) from a recognized Board, in accordance with UGC norms. Additionally, candidates must have secured at least 40% marks in the qualifying examination.

Candidates must also fulfill all documentation requirements as specified on the program's website for admission purposes. Failure to submit proof of eligibility within the stipulated timeframe specified by CDOE-JNU will result in the cancellation of admission. Prospective candidates are encouraged to carefully review all instructions provided on the website before proceeding with the application process.

2.1.2 Admission Process and Instructions: Learner Communication

The admission process for the students is provided below:

Step	Process	Particulars
Step 1	**Counselling**	Prospective students will receive guidance and counseling for their chosen program from designated and authorized counselors.
Step 2	**Registration on admission portal to get access to My Account.**	To initiate the registration process, prospective students are required to complete the application form by providing all necessary details and uploading mandatory documents.
Step 3	**Details of Document upload**	Student Uploads document as follows- <u>Personal Documents</u> Passport-size Photograph Student's Signature Aadhar Card (Back & Front) <u>Academic Documents</u> *UG Student -* 10th Marksheet 12th Marksheet *PG Student -* 10th Marksheet 12th Marksheet UG Marksheet Other Certificates (detailed list of documents is provided in **Annexure II**)
Step 4	**Verification of documents by the Deputy Registrar**	The Deputy Registrar is responsible for verifying all documents uploaded by prospective students on the admission portal. Within a timeframe of 48 hours, the Deputy Registrar will review and either approve or disapprove the eligibility of the prospective student for the chosen program.
Step 5	**Undertaking**	Student will sign Undertaking after Approval in Application.

Step 6	**Payment of fees**	All eligible students, duly approved by the Deputy Registrar, will get fees payment link activated in their My Account for payment. The Fee is payable through any of the following means: (a) UPI (b) Credit/Debit Card (c) Net-banking Note: Cash, bank demand draft and Cheques are not accepted
Step 7	**Enrolment**	After the payment of program fee, the eligible student will get the Enrolment number and access to the LMS within 21 days.
Step 8	**Access to Learning Management System (LMS)**	

General Instructions:

1. Prior to applying for distance programs, all students are advised to thoroughly read and comprehend the eligibility conditions provided in the student handbook document and outlined on the university website.
2. It is the responsibility of prospective learners to ensure that their educational or qualifying degree has been issued by a recognized university or board only. For learners from Indian higher education institutions, recognition by the regulatory authority of the Government of India is necessary. To verify degrees from recognized boards of education, refer to www.cobse.org.in/. For Polytechnic Diploma, check the respective State Board of Technical Education. Verification of degrees from recognized universities can be done at www.ugc.ac.in/.
3. Prospective learners must verify their eligibility on the date of admission and ensure that they have passed the qualifying exams before the commencement of the admission batch.

Upon enrollment, students must register with the Academic Bank of Credits (ABC), a central scheme for depositing credit formulated by the Ministry of Education, Government of India. Creation of an Academic Bank of Credits (ABC) ID is mandatory for all students. (Refer to Annexure V for details).

2.1.3 Program Fee for the Academic Session beginning July 2024

Program fees for students pursuing BSC-PCM offered by CDOE-JNU is mentioned below:

Program	Academic Total Fees (INR)	Exam fees
B.Sc. (PCM)	**54,000**	**1500 per semester**

2.2 Curriculum Transactions

2.2.1 Program Delivery

The curriculum is delivered through Self Learning Materials (SLMs) in the form of e-Contents, supplemented by a variety of learning resources including audio-video aids via the Learning Management System (LMS). Furthermore, the program includes contact hours featuring discussion forums and synchronous live interactive sessions conducted through the LMS, adhering to the current UGC norms for course delivery.

2.2.2 Learning Management System to support distance mode of Course delivery

The Learning Management System (LMS) is available on URL https://lms.jnujaipur.ac.in/ is meticulously developed to offer students a truly global learning experience. With a user-friendly interface, the LMS simplifies the learning process and ensures it meets the highest global standards. Utilizing audio-visual teaching methods, self-learning materials, discussion forums, and evaluation patterns, the platform stands out as unique and aligns seamlessly with both industry requirements and the UGC Guidelines.

Students can engage in uninterrupted learning 24x7 via web and mobile devices, allowing them to progress at their preferred pace. The LMS boasts a simple and intuitive user interface, facilitating easy navigation through the e-learning modules. Designed in accordance with standard norms, all learning tools are easily accessible, ensuring a perfect learning experience for all users.

2.2.3 Course Design

The curriculum is designed by a committee comprising experts from the parent department of the University and Industry experts, keeping in view the needs of the diverse groups of learners.

2.2.4 Academic Calendar for Academic Session beginning July 2024

S. No.	Event	Session	Month (Tentative)
1.	Commencement of semester	January	January

		July	July
2.	Enroll learner to Learning Management system	January	Within 21 working days from fee deposit and Eligibility confirmation
		July	
3.	Interactive Live Lectures for query resolution	January	February to May
		July	August to November
4.	Assignment Submission	January	By April
		July	By October
5	Project Report Submission (Wherever applicable during Final semester)	January	Last week of April
		July	Last week of November
6	Term End Examination	January	May onwards
		July	December onwards
7	Result Declaration of End Term Examination	January	By June
		July	By January

3. Instructional Design

3.1 Curriculum Design

The curriculum is meticulously designed by experts in the field of chemistry, mathematics and physics. It aims to improve the student's thinking, analytical, and problem-solving abilities with the advancement of the course. The course primarily focuses on developing professionals who are aware of the functional and fundamental aspects of the Universe. It establishes the foundation of science, and applicants understand the chemical, physical, and mathematical sciences. It has received approval from the Board of Studies, the Centre for Internal Quality Assurance (CIQA), and the University Academic Council.

3.1.1 Program Structure

I Semester									
S. No.	Paper Title	Code	Course Category	Credits	Contact-Per Week			Evaluation	
					L	T	P	Internal	External
1	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	DBSPCO101T24	CORE	3	2	1	0	30	70
2	Wave Mechanics	DBSPCO102T24	CORE	3	2	1	0	30	70
3	Differential Calculus	DBSPCO103T24	CORE	4	3	1	0	30	70
4	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons lab	DBSPCO101P24	CORE	1	0	0	2	30	70
5	Wave Mechanics Lab	DBSPCO102P24	CORE	1	0	0	2	30	70
6	**C++ and DSA	DBSPDS101T24	DSE	3	2	1	0	30	70
	*Object Oriented Programming	DBSPDS102T24							
7	C++ and DSA lab	DBSPDS101P24	DSE	1	0	0	2	30	70
	Object Oriented Programming lab	DBSPDS102P24							
8	Environmental Sciences	DBSPAE101T24	AECC-1	2	2	0	0	30	70
9	*Chemiinformatics	DBSPSE101T24	SEC-1	3	3	0	0	30	70
Total				21				900	

*Students can obtain credits from MOOC

** Student can obtain credits from University course or from MOOC

II Semester									
S. No.	Paper Title	Code	Course Category	Credits	Contact-Per Week			Evaluation	
					L	T	P	Internal	External
1	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I	DBSPCO201T24	CORE	3	2	1	0	30	70
2	Optics	DBSPCO202T24	CORE	3	2	1	0	30	70
3	Differential Equation	DBSPCO203T24	CORE	4	3	1	0	30	70
4	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab	DBSPCO201P24	CORE	1	0	0	2	30	70
5	Optics Lab	DBSPCO202P24	CORE	1	0	0	2	30	70
6	Database Management System	DBSPDS201T24	DSE	3	2	1	0	30	70
	Information Security	DBSPDS202T24							
7	Database Management System lab	DBSPDS201P24	DSE	1	0	0	2	30	70
	Information Security lab	DBSPDS202P24							
8	English	DBSPAE201T24	AECC-2	2	2	0	0	30	70
9	Mathematical Physics-I	DBSPSE201T24	SEC-2	3	3	0	0	30	70
Total				21	24			900	

Exit option with UG certificate *Students will be awarded UG Certificate in Basic Sciences provided they secure 4 credits in vocational courses /summer internship in addition to 6 credits from skill based courses earned during 1st and 2nd semester.

III Semester									
S. No.	Paper Title	Code	Course Category	Credits	Contact-Per Week			Evaluation	
					L	T	P	Internal	External
1	Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II	DBSPCO301T24	CORE	3	2	1	0	30	70
2	Thermodynamics and Statistical Physics	DBSPCO302T24	CORE	3	2	1	0	30	70
3	Real Analysis	DBSPCO303T24	CORE	4	3	1	0	30	70
4	Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab	DBSPCO301P24	CORE	1	0	0	2	30	70
5	Thermodynamics and Statistical Physics Lab	DBSPCO302P24	CORE	1	0	0	2	30	70
6	Digital Systems and Applications	DBSPDS301T24	DSE	3	2	1	0	30	70
	Instrumental Methods of Analysis	DBSPDS302T24							
	Partial Differential Equations	DBSPDS303T24							
7	Digital Systems and Applications lab	DBSPDS301P24	DSE	1	0	0	2	30	70
	Instrumental Methods of Analysis lab	DBSPDS302P24							
	Partial Differential Equations lab	DBSPDS303P24							
8	Professional Communication Skills	DBSPAE301T24	AECC-3	2	2	0	0	30	70
9	Green Methods in Chemistry	DBSPSE301T24	SEC-3	3	3	0	0	30	70
Total				21	24			900	

IV Semester									
S. No.	Paper Title	Code	Course Category	Credits	Contact-Per Week			Evaluation	
					L	T	P	Internal	External
1	Transition Metal & Coordination chemistry, States of Matter & Chemical Kinetics	DBSPCO401T24	CORE	3	2	1	0	30	70
2	Electricity and Magnetism	DBSPCO402T24	CORE	3	2	1	0	30	70
3	Abstract Algebra	DBSPCO403T24	CORE	4	3	1	0	30	70
4	Transition Metal & Coordination chemistry, States of Matter & Chemical Kinetics Lab	DBSPCO401P24	CORE	1	0	0	2	30	70
5	Electricity and Magnetism Lab	DBSPCO402P24	CORE	1	0	0	2	30	70
6	Analytical Methods in Chemistry	DBSPDS401T24	DSE	3	2	1	0	30	70
	Atomic and Molecular Physics	DBSPDS402T24							
	Mathematical Methods	DBSPDS403T24							
7	Analytical Methods in Chemistry Lab	DBSPDS401P24	DSE	1	0	0	2	30	70
	Atomic and Molecular Physics lab	DBSPDS402P24							
	Mathematical Methods lab	DBSPDS403P24							
8	Intellectual Property Rights	DBSPAE401T24	AECC-4	2	2	0	0	30	70
9	Quantitative Aptitude	DBSPVA401T24	VAC-1	2	2	0	0	30	70
10	Food Hygiene and Sanitation	DBSPGE401T24	OE/GE -1	2	2	0	0	30	70
	Fundamentals of Prescribing	DBSPGE402T24							
	Human Resource Management	DBSPGE403T24							
Total			22		25			1000	
Exit option with UG Diploma*Students will be awarded UG Diploma in Life Sciences provided they secure additional 4 credits in Skill based vocational courses /summer internship offered during 1st or 2nd year..									
* Open Elective credits could be replaced with options of MOOC and SWAYAM courses									

Semester – V									
S.No.	Paper Title	Code	Course Category	Credits	Contact-Per Week			Evaluation	
					L	T	P	Internal	External
1	Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy	DBSPCO501T24	CORE	3	2	1	0	30	70
2	Solid State Physics	DBSPCO502T24	CORE	3	2	1	0	30	70
3	Probability and Statistics	DBSPCO503T24	CORE	4	3	1	0	30	70
4	Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy Lab	DBSPCO501P24	CORE	1	0	0	2	30	70
5	Solid State Physics Lab	DBSPCO502P24	CORE	1	0	0	2	30	70
6	Inorganic Materials of Industrial Importance	DBSPDS501T24	DSE	3	2	1	0	30	70
	Nuclear Physics	DBSPDS502T24							
	Operating System LINUX	DBSPDS503T24							
7	Inorganic Materials of Industrial Importance Lab	DBSPDS501P24	DSE	1	0	0	2	30	70
	Nuclear Physics lab	DBSPDS502P24							
	Operating System LINUX lab	DBSPDS503P24							
8	Web Designing	DBSPVA501T24	VAC-2	2	2	0	0	30	70
9	Diet in Life Style disorders	DBSPGE501T24	*OE/GE-2	2	2	0	0	30	70
	Essential Newborn Care (ENBC) & Facility based newborn care (FBNC)	DBSPGE502T24							
	Marketing Management	DBSPGE503T24							
Total			20		23			900	

* Open Elective credits could be replaced with options of MOOC and SWAYAM courses

Semester – VI									
S. No.	Paper Title	Code	Course Category	Credits	Contact-Per Week			Evaluation	
					L	T	P	Internal	External
1	Quantum Chemistry, Spectroscopy & Photochemistry	DBSPCO601T24	CORE	3	2	1	0	30	70
2	Quantum Mechanics and Applications	DBSPCO602T24	CORE	3	2	1	0	30	70
3	Linear Programming Problem	DBSPCO603T24	CORE	4	3	1	0	30	70
4	Quantum Chemistry, Spectroscopy & Photochemistry lab	DBSPCO601P24	CORE	1	0	0	2	30	70
5	Quantum Mechanics and Applications Lab	DBSPCO602P24	CORE	1	0	0	2	30	70
6	Molecular Modelling& Drug Design	DBSPDS601T24	DSE	3	2	1	0	30	70
	Nanotechnology and Applications	DBSPDS602T24							
	Numerical Methods	DBSPDS603T24							
7	Molecular Modelling & Drug Design lab	DBSPDS601P24	DSE	1	0	0	2	30	70
	Nanotechnology and Applications lab	DBSPDS602P24							
	Numerical Methods Lab	DBSPDS603P24							
8	Fundamentals of Indian Constitution	DBSPVA601T24	VAC-3	2	2	0	0	30	70
9	Techniques in Basic Life Support	DBSPGE601T24	*OE/GE-3	2	2	0	0	30	70
	Integrated Management of Neonatal and Childhood Illness (IMNCI) & Pediatric Life Support (PLS)	DBSPGE602T24							
	Leadership Skills and Change Management	DBSPGE603T24							
Total				20	23			900	

* Open Elective credits could be replaced with options of MOOC and SWAYAM courses

3.2.2 Detailed Syllabus of BSC-PCM

Detailed syllabus of B.Sc.-PCM is attached in Annexure-I.

3.3 Duration of the Program

Program	Level	Duration	Maximum duration for completion	Credits
BSc.-PCM	Bachelor's Degree	3 years (6 Semesters)	6 Years	125

3.4 Faculty and Support staff requirements (Refer Regulation Document for all Staff Details)

Academic Staff	Number available to meet the norms
Program Coordinator	1 Member
Course Coordinator	55
Course Mentor	1 Member per batch of 250 students

3.5 Instructional delivery mechanisms

JNU boasts a fully dedicated team of faculty members and staff proficient in delivering lectures through CDOE – JNU. At the commencement of each session, students will receive the academic calendar via the Learning Management System (LMS). The distribution of self-learning material, audio, and video content to students will be facilitated through the LMS via the following delivery channels:

- Self-Learning Material
- EBooks
- Study Guide
- Question Bank in Learning Management system - For Practice Test through LMS
- Audio / Video Component in Learning Management System
- Assignments (Submitted through Assignment Response Sheet)
- Personal Contact Program would be conducted at University Campus.

3.6 Identification of media-print, audio, or video, online, computer aided

The Learning Management System (LMS) serves as a comprehensive digital platform, offering a multitude of features including recorded faculty video lectures, real-time discussion forums, live sessions, e-content

comprising study material, open source materials, and graded assessments.

For each module within a course, there will be one live session conducted by the respective faculty member, focusing on a specific topic. CDOE-JNU has curated study material that is clear and easily comprehensible, complete with concise summaries, self-assessment questions, and case studies.

Access to these course materials is facilitated through:

- Login credentials provided in the welcome email sent by the university
- Students can also log in on the University website at https://online.jnujaipur.ac.in/

Courseware

Through the Learning Management System (LMS), students will have access to a comprehensive array of course materials mentioned in above clause.

The Dashboard feature of the LMS serves to track and monitor students' learning progress. It includes functionalities such as:

- Monitoring progress in learning
- Comparing progress with peers
- Receiving regular notifications about upcoming webinars, virtual classes, assignments, discussion forum participations, and examinations

3.7 Student Support Services

Students will have access to support services provided by CDOE-JNU through the Student Relationship Management (SRM) system for queries related to administration and general technical issues. A ticketing system integrated into the LMS will enable learners to connect with the CDOE-JNU technical team for support services, with resolutions handled by the appropriate authority. Notifications will also be sent to the Deputy Registrar to ensure queries are addressed within 24 hours or sooner.

For academic course-related queries, students can raise queries directly through an open discussion forum, which will notify the Course Coordinator, Program Coordinator, and Deputy Director. Queries should be resolved within 48 hours of being raised, with the Program Coordinator responsible for managing and resolving any unresolved matters. The Deputy Director will ensure the timely resolution of academic queries.

In addition to academic excellence, CDOE-JNU prioritizes the holistic development of its students. The department supports various initiatives to broaden students' opportunities and shape them into future leaders.

4. Assessment and Evaluation

4.1 Overview

The evaluation of students' learning will encompass internal assignments, quizzes, learner response sheets, and end-of-term examinations. CDOE-JNU follows a rigorous process in the development of question papers, creation of question and quiz banks, preparation and moderation of assignments, administration of examinations, analysis of answer scripts by qualified academics, and declaration of results. Question papers are meticulously framed to ensure comprehensive coverage of the syllabus.

The evaluation process will include two types of assessments:

Examination Name	Marks Division
Continuous internal assessment	30%
Summative assessment in the form of end-term examination. End-term examination will be held with proctored examination tool technology (follow **Annexure VI** for guidelines and pre-requisites for Proctored Examination)	70%

The examinations are designed to evaluate the knowledge acquired during the study period. For theory courses, internal evaluation will be conducted through Continuous Internal Assessment (CIA), which includes assignments and quizzes in form of MCQ type of questions. The internal assessment will contribute a maximum of 30 marks for each course.

At the end of each semester, an end-of-semester examination will be held for each course, lasting two hours.

Guidelines issued by the Regulatory Bodies from time-to-time about conduct of examinations shall be considered and new guidelines if any will be implemented.

4.2 Question Paper Pattern

Exam Time: 2 Hours

Max. Marks: 70

Exam will be comprising of 70 Multiple-Choice Questions (1 Mark each) – 70 Marks

4.3 Distribution of Marks in Continuous Internal Assessments

The following procedure shall be followed for internal marks for theory courses. Weightage for Assignment is provided below:

Particular	A1 (MCQ Type)	A2 (MCQ Type)
Marks	15	15

Note: Refer to **Annexure VI** and **VII** for reference to the question paper pattern and formats of documents accepted.

Students may re-appear for CIA up to next two semesters and has to follow the same procedure. For the last semester the academic rules shall apply.

4.4 Statistical Method for the Award of Relative Grades

Letter Grade	Grade point	Range of Marks (%)
O (Outstanding)	10	90-100
A+ (Excellent)	9	80-89
A (Very good)	8	70-79
B+ (Good)	7	60-69
B (Above average)	6	50-59
C (Average)	5	40-49
p (Pass)	4	35-39
F (Fail)	0	0-34
Ab (Absent)	0	Absent

Abbreviations:

CO	Core Course	MM	Maximum Marks
DS	Discipline Specific Course	MO	Marks Obtained
GE	Generic Elective Course		

4.4.1 Cumulative Grade Point Average (CGPA) and Semester Grade Point Average

Semester Grade Point Average (SGPA):

It is the summation of product of Credit Points and Grade Points divided by the summation of Credits of all Courses taught in a semester.

SGPA = $\Sigma C.G. / \Sigma C$

Where, G is grade and C. is credit for a Course.

Cumulative Grade Point Average (CGPA): $CGPA = \Sigma(C_i \times Si)/\Sigma c$.

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

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

Note:

- In case of any mistake being detected in the preparation of the Grade Statement at any stage or when it is brought to the notice of the concerned authority the University shall have the right to make necessary corrections.

4.4.2 Cumulative Grade Point Average (CGPA)

CGPA will be used to describe the overall performance of a student in all courses in which letter grades are awarded since his entry into the University or transferred from other University up to the latest semester as per the procedure provided in JNU Academic Regulations. It is the weighted average of the grade points of all the letter grades received by the student from his entry into the University or transferred from other University. Since multiple performance in a course in which the student has already received a grade is possible, whenever through such a process a new grade is obtained, it will replace the earlier one in the calculation of CGPA. On the other hand, if through this process merely a report emerges, this event by itself will not alter the CGPA.

A student's grades, reports, CGPA, etc. at the end of every semester/term will be recorded on a grade card, a copy of which will be issued to him. The grade card will be withheld if a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.

The faculty members also responsible for maintaining the complete records of each student's attendance, performance in different components of evaluation. If a scrutiny or statistical analysis becomes necessary, the above records and any other pertinent information should be made available by the faculty member of the course.

4.4.3 Conversion Factor

Formula for Conversion of CGPA to Percentage:

Percentage of marks = CGPA ^{x} 10

4.5 Grade card

All grades and reports and other pertinent information for a semester are given in a grade card which is a complete record of the outcome of what was intended in the original registration. The various grades and reports would be appropriately used to tally the grade card with the original registration.

Chronologically organized information from the grade cards of a student with the necessary explanation constitutes is transcript which is issued at the time the student leaves the University or at an intermediate point on request.

4.5.1 Grade cards and Certification – Student Communication

- The student can get soft copy of grade cards through the University website, the hard copy grade card would be provided only after successfully completion of full program along with degree certificate.
- Once the student completes all the mandated assignments, examinations and projects (if applicable) the final mark sheet/grade card and certificate would be dispatched by the University to the student registered address.
- All pending payments/dues need to be cleared by the student, before the final certification.
- If required, the University may request the mandatory documents from student as submitted during admission time, the students may have to re-submit the same if required during final degree certification.
- Students need to apply for degree by filling the degree application form and submit all the required documents and the applicable degree processing application fees as mentioned in this document.

4.5.2Results, grade card and Degree Logistics–Internal Process

- After verification of all data by the Controller of Examination, the results would be published on the CDOE-JNU website.
- Students need to download and save the copy of semester / year wise results.

CDOE-JNU would provide hard copy grade cards and degree certificate at the end of the program to students who have successfully completed the program. Students who successfully completed the program will receive hard copy mark sheet/grade cards and a degree certificate from the University at the end of the program. A provision for On Demand Mark Sheets can be provided wherein student would have to fill the requisition and pay postal charges enabling university to dispatch the hard copy mark sheets as requested by the student; prior to completion of the overall program.

5. Requirement of the Laboratory Support and Library Resources

5.1 Laboratory Support

Jaipur National University offers access to state-of-the-art laboratories equipped with the latest tools and resources necessary for research and analytical work. The laboratory support at JNU aims to foster a robust research environment, encouraging students to develop essential skills required for their academic and professional growth.

5.*2 Library Resources*

The Central Library at CDOE-JNU offers a comprehensive range of sections, including reference, circulation, audio-visual, periodical, book-bank, digital library, and reprographic sections. With a collection exceeding 1,00,000 books, the library also provides access to e-journals, online databases such as Scopus and Web of Science, and institutional repositories featuring rare book collections. University has 449 subscriptions of online and offline Journals. Equipped with modern facilities like reading rooms, computer labs, and quiet study areas, the library fosters a conducive environment for learning and intellectual growth. Additionally, the library frequently organizes workshops, seminars, and exhibitions to enhance academic engagement and promote a culture of continuous learning.

All electronic resources can be accessed seamlessly through the Local Area Network (LAN) on campus, as well as remotely via login credentials. This ensures convenient access to resources for students, faculty, and researchers both on-site and off-site.

6. Cost Estimate of the Program and the Provisions

The Estimate of Cost & Budget could be as follows (all figures on Annual basis):

Sl. No.	Expenditure Heads	Approx. Amount
1	Program Development (Single Time Investment)	43,00,000 INR
2	Program Delivery (Per Year)	8,00,000 INR
3	Program Maintenance (Per Year)	27,00,000 INR

7. Quality Assurance Mechanism

The quality of a program hinges upon the course curriculum, syllabus, and academic delivery, all of which are meticulously designed to bridge the gap between industry standards and academia. To uphold this standard, the

Centre for Internal Quality Assurance (CIQA) and the Academic Council play crucial roles.

The Academic Council is entrusted with ratifying the curriculum and any proposed changes recommended by CIQA to ensure the continual enhancement and maintenance of quality in education at CDOE-JNU.

The Centre for Internal Quality Assurance (CIQA) is tasked with several responsibilities:

(i) Conducting periodic assessments of learning course materials and audio-video tutorials to maintain the quality of learning.

(ii) Soliciting stakeholder feedback and implementing recommended changes to meet the evolving needs of course delivery and industry requirements.

(iii) Evaluating the quality of assignments, quizzes, and end-term assessments and providing suggestions for enhancements to sustain the learning program's standards.

(iv) Ensuring that the learning experience is truly global, aligning with program outcomes and reflecting the vision and mission of JNU.

The Chief Operating Officer (CoE) of the University oversees examinations and the evaluation system to ensure fairness and integrity in the assessment process.

CDOE-JNU is committed to continual improvement, striving to enhance processes, assessments, teaching methodologies, and e-learning materials in line with the regulatory norms. The University is dedicated to delivering exceptional education across all learning modes while adhering to NEP, UGC, and other regulatory guidelines, fostering a truly global educational environment.

****

Annexure I _Detailed syllabus of B.Sc.-PCM Program

Program Outcomes

PO1. **Critical thinking**: Identify and analyze current issues and trends in higher education and come-up with intellectual, organizational, and personal ideas and decisions from different perspectives.

PO2. **Effective communication**: Communicate clearly and effectively using the professional standards of their fields.

PO3. **Environment and sustainability**: Understand the issues of environmental contexts and demonstrate the knowledge for sustainable development.

PO4. **Ethics**: Express legal and ethical issues and understand the moral dimensions of decisions and responsibilities.

PO5: **Open communication**: Ability to communicate mathematics effectively by written, computational and graphic means.

PO6. **Life-long learning**: Gain ability to engage in independent and life-long learning with socio-technological changes.

PO7. **Decision making and Analytical skills**: Understand and demonstrate the knowledge of physical and chemical sciences in societal and environmental contexts.

PO8. **Individual and team work**: Work competently as an individual or in a team in one or more core areas of physics, maths and chemistry.

PO9. **Modern tool usage**: Apply modern tools and techniques for prediction and modelling of complex physical and chemical activities with an understanding of the limitations.

PO10. **Problem Solving**: Design solutions and novel products to meet the specified needs with appropriate consideration for the public health and safety.

The detailed syllabus for the Program is as follows

I-Semester

Course Code **DBSPCO101T24**	**Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution.	
CO 2	Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).	
CO 3	Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.	
CO 4	Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.	
CO 5	Learn and identify many organic reaction mechanisms including free radical substitution, electrophilic addition and electrophilic aromatic substitution.	
CO 6	Create the mechanism of reaction of hydrocarbons.	
Course Content		
Block- I	Atomic Structure	
	Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m, *l* and m *s*. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m*s*).Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	
Block-II	Chemical Bonding and Molecular Structure	
	Ionic Bonding*:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.	

	Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.
Block-III	Fundamentals of Organic Chemistry
	Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions, free radicals and carbenes. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule. Stereochemistry Conformations with respect to ethane, butane and cyclohexane.Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer projection. Concept of chirality (upto two carbon atoms).Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D andL; *cis- trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E /Z Nomenclature (for upto two C=C systems).
Block-IV	Aliphatic Hydrocarbons
	Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration ofalkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes(Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cisaddition(alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Lee., J. D. A new Concise Inorganic Chemistry, Pearson Education. 2. Huheey, J.E.; Keiter, E.; Keiter, R. (2009),Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication. 3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010),Shriver and Atkin's Inorganic Chemistry, Oxford 4. Sykes, P.(2005), A Guide Book to Mechanism in Organic Chemistry, Orient

	Longman. 5. Eliel, E. L. (2000), Stereochemistry of Carbon Compounds, Tata McGraw Hill. 6. T.W.Graham Solomons, Craig B. Fryhle (2008) 9th edition, "Organic Chemistry", Willey India Edition. 7. Robert Thornton Morrison, Robert Neilson Boyd (2011) 7th edition, "Organic Chemistry", Pearson. 8. John Mc. Murry (2009), "Introduction of Organic Chemistry", India Edition. Finar, I.L. Organic Chemistry (Vol 1 & 2), Dorling Kindersley (India) Pvt Ltd (Pearson Education)

Course Code **DBSPCO102T24**	**Wave Mechanics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO1	Understand physical characteristics of SHM and obtaining solution of the oscillator using differential equations.	
CO2	Calculate logarithmic decrement relaxation factor and quality factor of a harmonic oscillator.	
CO3	Use Lissajous figures to understand simple harmonic vibrations of same frequency and different frequencies.	
CO4	Solve wave equation and understand significance of transverse waves.	
CO5	Analyze Reflection of waves from free and fixed boundaries and phase change at the boundaries.	
CO6	Can apply boundary condition.	
Course Content		
Block I	Superpositions of Harmonic Oscillations	
	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. Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.	
Block II	Wave Motion	
	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. 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. 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. Longitudinal Standing Waves and Normal Modes.	
Block III	Simple Harmonic Motion & Ultrasonic waves I	
	Differential equation of simple harmonic motion and its solution. Damped and Forced harmonic oscillations, Sharpness of Resonance. Quality factor. Transport of energy along strings. Reflection of waves from free and fixed boundaries and phase change at the boundaries. Principle of superposition of waves. Standing waves and resonance. Ultrasonic: Ultrasonic, properties of ultrasonic waves, production of ultrasonic by piezoelectric and magnetostriction methods, detection of ultrasonic, determination of wavelength of ultrasonic waves. Velocity of ultrasonic in liquids by Sear's method. Applications of ultrasonic waves.	
Block IV	Vibrations of bars	

	Vibrations of bars: Longitudinal vibrations in bars – wave equation and its general solution. Special cases (i) bar fixed at both ends ii) bar fixed at the midpoint iii) bar free at both ends iv) bar fixed at one end. Transverse vibrations in a bar – wave equation and its general solution. Boundary conditions, clamped free bar, free – free bar, bar supported at both ends, Tuning fork.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley. 2. Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill. 3. Physics – Resnick, Halliday& Walker 9/e, 2010, Wiley 4. Engineering Mechanics, Basudeb Bhattacharya, 2ndedn., 2015, Oxford University Press 5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Course Code **DBSPCO103T24**	**Differential Calculus**	**C-4**
Course Outcomes	After completion of this course, a student will be:	
CO 1	To understand the idea of derivative.	
CO 2	To understand idea of a tangent line to the graph of a function.	
CO 3	To know how a derivative can be used to describe the rate of change of one quantity with respect to another.	
CO 4	To relate the geometric ideas to the analytic ideas.	
CO 5	To state the definition of derivative and compute with it.	
CO 6	To compute basic limits of functions.	
Course Content		
Block I	Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Differentiation for implicit functions, Leibnitz'stheorem.Partialdifferentiation,Chainruleofpartialdifferentiation,,Euler'stheor emonhomogeneousfunctions.Total derivatives, Maxima and Minima for the functions of two and more independent variables, Lagrange's method of undetermined multipliers	
Block II	Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cos x, ex , log(l+x), (l+x)m, Maxima and Minima, Indeterminate forms. Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type eax+bsinx, e ax+bcosx, (ax+b)nsinx, (ax+b)ncosx, concavity and inflection points, L'Hospital's rule.	
Block III	Tangents and normal, Curvature- various formulae, centre of curvature, chord of curvature, concavity, convexity and Point of inflexion (Cartesian Coordinates only), Asymptotes of general algebraic curves, Singular points, Tracing of curves. Rectification and Area of simple curves .Polar coordinates and tracing of curves in polar coordinates	
Block IV	Parametric equations, parameterizing a curve, length of parametric curves, area and volume of surface of solid revolution. Multiple integral, Change of order of integration. Beta and gamma function.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. MD. Anwarul Haque, 1992 (First Edition), "Calculus of one Variable", New Age International Publication, New Delhi 2. Gupta &Kapoor, 2000 (First Edition), " Text book of differential calculus", S. Chand Publication, New Delhi. 3. A.R. Vasishtha, S.K. Sharma, A. K. Vasishtha, 1989 (First Edition)"Differential Calculus", Krishna Prakashan Media, Meerut.	

Online resources	https://www.coursera.org/ https://www.khanacademy.org/ https://alison.com/tag/maths

Course Code **DBSPCO101P24**	**Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Student can follow the concepts of Volumetric analysis.	
CO 2	To organize a sequence to Identify hetero atoms in organic compounds.	
CO 3	To demonstrate the protocol for Separation of mixtures by Chromatography.	
CO 4	To create a complete sequence pathway to identify the organic compounds.	
CO 5	To estimate the amount of inorganic ion in different samples analytically.	
Exercises		
Exercise 1.	Section A: Inorganic Chemistry - Volumetric Analysis Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.	
Exercise 2.	Estimation of oxalic acid by titrating it with $KMnO_4$.	
Exercise 3.	Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.	
Exercise 4.	Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator	
Exercise 5.	Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$	
Exercise 6.	Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements)	
Exercise 7.	Separation of mixtures by Chromatography: Measurement the R_f value in each case (combination of two compounds to be given) (a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography (b) Identify and separate the sugars present in the given mixture by paper chromatography.	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C.(1989),Vogel's Textbook of Quantitative Chemical Analysis 5th Edn., John Wiley and Sons Inc,. 2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012),Vogel's Textbook ofPractical Organic Chemistry, Pearson. *3.* Mann, F.G.; Saunders, B.C.(2009),Practical Organic Chemistry, Pearson Education.	

Course Code **DBSPCO102P24**	**Wave Mechanics Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the principles of measurement and error analysis.	
CO 2	Perform Bar pendulum and Katter's pendulum for determination gravitational force.	
CO 3	Adapt skills to measure moment of inertia, young's modulus, poison ration and bending of beams.	
CO 4	Demonstrate the process of Measurements of length (or diameter) using Vernier caliper, screw gauge and travelling microscope.	
CO 5	To design the instrument for determine the Height of a Building using a Sextant.	
Exercises		
Exercise 1.	To determine the Moment of Inertia of a Flywheel.	
Exercise 2.	To determine the Elastic Constants of a Wire by Searle's method.	
Exercise 3.	To determine the Modulus of Rigidity of a Wire by Maxwell's needle.	
Exercise 4.	To determine g by Bar Pendulum.	
Exercise 5.	To determine g by Katter's Pendulum.	
Exercise 6.	To determine modulus of rigidity by bending of beam.	
Exercise 7.	To determine g and velocity for a freely falling body using Digital Timing Technique	
Exercise 8.	To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g	
Exercise 9.	Measurements of length (or diameter) using Vernier caliper, screw gauge and travelling microscope.	
Exercise 10.	To determine the Height of a Building using a Sextant.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House. 2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers. 3. Engineering Practical Physics, S. Panigrahi& B. Mallick, 2015, Cengage Learning India Pvt. Ltd. 4. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.	

Course Code **DBSPDS101T24**	**C++ and DSA**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	To analyze algorithms and algorithm correctness.	
CO 2	To summarize searching and sorting techniques.	
CO 3	To describe stack, queue and linked list operation.	
CO 4	To interpret tree and graphs concept.	
CO 5	Implement and know the application of algorithms for sorting and pattern matching.	
CO 6	Ability to design programs using a variety of data structures such as stacks, queues, hash tables, binary trees, search trees, heaps, graphs, and B-trees.	
Course Content		
Block I	**Arrays:** Single and Multi-dimensional Arrays, Sparse Matrices (Array and Linked Representation) Stacks Implementing single / multiple stack/s in an Array; Prefix, Infix and Postfix expressions, Utility and conversion of these expressions from one to another; Applications of stack; Limitations of Array representation of stack	
Block II	**List:** Linked Lists Singly, Doubly and Circular Lists (Array and Linked representation);Normal and Circular representation of Stack in Lists; Self Organizing Lists; Skip Lists	
Block III	**Queues Array:** Queues Array and Linked representation of Queue, De-queue, Priority Queues Recursion Developing Recursive Definition of Simple Problems and their implementation; Advantages and Limitations of Recursion; Understanding what goes behind Recursion (Internal Stack Implementation)	
Block IV	**Trees:** Trees Introduction to Tree as a data structure; Binary Trees (Insertion, Deletion , Recursive and Iterative Tra, Tversals on Binary Search Trees); Threaded Binary Trees (Insertion, Deletionraversals); Height-Balanced Trees (Various operations on AVL Trees).7.Searching and Sorting(5 Lectures)Linear Search, Binary Search, Comparison of Linear and Binary Search, Selection Sort, Insertion Sort, Insertion Sort, Shell Sort, Comparison of Sorting Techniques	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. Adam Drozdek, "Data Structures and algorithm in C++", Third Edition, Cengage Learning, 2012. 2. Sartaj Sahni, Data Structures, "Algorithms and applications in C++", Second Edition, Universities Press, 2011. 3. Aaron M. Tenenbaum, Moshe J. Augenstein, Yedidyah Langsam, "Data Structures Using C and C++: Second edition, PHI, 2009. 4. Robert L. Kruse, "Data Structures and Program Design in C++", Pearson, 1999. D.S Malik, Data Structure using C++, Second edition, Cengage Learning, 2010. 5. Mark Allen Weiss, "Data Structures and Algorithms Analysis in Java", Pearson Education, 3rd edition, 2011 6. Aaron M. Tenenbaum, Moshe J. Augenstein, Yedidyah Langsam, "Data Structures Using Java, 2003. 7. Robert Lafore, "Data Structures and Algorithms in Java, 2/E", Pearson/ Macmillan Computer Pub,2003 John Hubbard

Course Code **DBSPDS102T24**	**Object Oriented Programming**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Introduces Object Oriented Programming concepts using the C++ language.	
CO 2	Understand the difference between the top-down and bottom-up approach.	
CO 3	Describe the object-oriented programming approach in connection with C++.	
CO 4	Apply the concepts of object-oriented programming.	
CO 5	Illustrate the process of data file manipulations using C++.	
CO 6	Apply virtual and pure virtual function & complex programming situations.	
Course Content		
Block I	**OOP Paradigm** Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Object-based programming languages C++: Brief History of C++,Structure of a C++ program, Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers.	
Block II	**Enumeration, Arrays and Pointer** Implementing oops concepts in C++ Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value, Using Reference variables with Functions. Abstract data types, Class Component.	
Block III	**Application** Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers – private, public and protected. Implementing Class Functions within Class declaration or outside the Class declaration. Instantiation of objects, Scope resolution operator, Working with Friend Functions, Using Static Class members.	
Block IV	**Application** Understanding Compile Time Polymorphism function overloading Rules of Operator Overloading(Unary and Binary) as member function/friend function, Implementation of operator overloading of Arithmetic Operators, Overloading Output/Input, Prefix/ Postfix Increment and decrement Operators, Overloading comparison operators, Assignment, subscript and function call Operator , concepts of namespaces.	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. A. R. Venugopal, Rajkumar, and T. Ravishanker, M*astering C++*, TMH, 1997. 2. S. B. Lippman and J. Lajoie, *C++ Primer*, 3rd Ed., Addison Wesley, 2000. 3. Bruce Eckel, *Thinking in C++*, 2nd Ed., President, Mindview Inc., Prentice Hall. 4. D. Parasons, *Object Oriented Programming with C++*, BPB Publication. 5. BjarneStroustrup ,*The C++ Programming Language*, 3rd Ed., Addison Welsley	

Course Code **DBSPDS101P24**	**C++ and DSA lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	To Understand and remember algorithms and its analysis procedure.	
CO 2	To discuss the concept of data structures through ADT including List, Stack, Queues.	
CO 3	To apply various techniques for representation of the data in the real world..	
CO 4	To develop application using data structure algorithms.	
CO 5	To design and implement various data structure algorithms.	
Exercises		
Exercise 1.	Write a program to search an element from a list. Give user the option to perform Linear or Binary search. Use Template functions.	
Exercise 2.	WAP using templates to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or Selection sort	
Exercise 3.	Implement Linked List using templates. Include functions for insertion, deletion and search of a number, reverse the list and concatenate two linked lists (include a function and also overload operator +).	
Exercise 4.	Implement Doubly Linked List using templates. Include functions for insertion, deletion and search of a number, reverse the list.	
Exercise 5.	Implement Circular Linked List using templates. Include functions for insertion, deletion and search of a number, reverse the list.	
Exercise 6.	Perform Stack operations using Linked List implementation.	
Exercise 7.	Perform Stack operations using Array implementation. Use Templates.	
Exercise 8.	Perform Queues operations using Circular Array implementation. Use Templates.	
Exercise 9.	Create and perform different operations on Double-ended Queues using Linked List implementation.	
Exercise 10.	WAP to scan a polynomial using linked list and add two polynomial.	
Exercise 11.	WAP to calculate factorial and to compute the factors of a given no. (i)using recursion, (ii) using iteration	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Data Structures and Algorithms, 2008, G. A. V. Pai, TMH 2. Classic Data Structures, 2/e, Debasis , Sarnanta,PHI,2009 3. Fundamentals of Data Structure in C, 2le,' Horowitz, Sahni, Anderson Freed, University Press	

Course Code **DBSPDS102P24**	**Object Oriented Programming lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Describe the procedural and object oriented paradigm with concepts of streams, classes, functions, data and objects.	
CO 2	Understand dynamic memory management techniques using pointers, constructors, destructors, etc	
CO 3	Describe the concept of function overloading, operator overloading, virtual functions and polymorphism.	
CO 4	Classify inheritance with the understanding of early and late binding, usage of exception handling, generic programming.	
CO 5	Draw C++ program for a student mark list processing using virtual base class.	
Exercises		
Exercise 1.	To write a c++ program to illustrate the concept of Classes and objects.	
Exercise 2.	To create a mark list using arrays in c++ programming language.	
Exercise 3.	To write a c++ program to perform operation on string class.	
Exercise 4.	To write a c++ program to implement static member function.	
Exercise 5.	To write a c++ program to implement friend function.	
Exercise 6.	To write a c++ program to display the details of a person using constant member function.	
Exercise 7.	To write a c++ program to illustrate the concept of unary operator overloading.	
Exercise 8.	To write a c++ program to illustrate the concept of Binary operator overloading.	
Exercise 9.	To write a c++ program to illustrate the concept of function overloading.	
Exercise 10.	To write a c++ program to implement various constructors and destructors.	
Exercise 11.	To write a c++ program to multiply the positive numbers using single inheritance.	
Exercise 12.	To write a c++ program using multiple inheritances for collecting employee details.	
Exercise 13.	To write a c++ program for calculation of area of shapes using virtual functions.	
Exercise 14.	To write a c++ program for a student mark list processing using virtual base class.	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. A. R. Venugopal, Rajkumar, and T. Ravishanker, M*astering C++*, TMH, 1997. 2. S. B. Lippman and J. Lajoie, *C++ Primer*, 3rd Ed., Addison Wesley, 2000. 3. Bruce Eckel, *Thinking in C++*, 2nd Ed., President, Mindview Inc., Prentice Hall. 4. D. Parasons, *Object Oriented Programming with C++*, BPB Publication. 5. BjarneStroustrup ,*The C++ Programming Language*, 3rd Ed., Addison Welsley.	

Course Code **DBSPAE101T24**	**Environmental Sciences**	**C-2**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define the intellectual flexibility necessary to view environmental questions from multiple perspectives.	
CO 2	Prepared to alter their understanding as they learn new ways of understanding.	
CO 3	Learn about Renewable and nonrenewable recourses.	
CO 4	Able to discuss Social issues and the Environment.	
CO 5	Differentiate Renewable and nonrenewable recourses.	
CO 6	Develop Social issues and Environment issue.	
Course Content		
Block I	**Ecosystems and Biodiversity and its conservation** Ecosystems: Concept of ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic structure and function of the following ecosystems: Forest ecosystems, Grassland ecosystems, Desert ecosystems, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) Biodiversity and its conservation Introduction: definition: genetic, species and ecosystem diversity; Biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national and local levels; India as a mega –diversity nation; Hotspots of biodiversity ; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity	
Block II	**Environmental Pollution** Environmental Pollution: Definition; Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution Solid waste management: Causes, effects and control measures of urban and industrial wastes Disaster management: floods, earthquakes, cyclones and landslides Human Population and the Environment Population growth, variation among nations; Population explosion – Family welfare Programme Environment and human health; Human Rights; Intellectual Property Rights(IPR);Value Education; HIV/AIDS; Women and child welfare Role of Information Technology in Environment and human health; Case Studies	

Block III	**Natural Resources:** Renewable and nonrenewable recourses Natural resources and associated problems Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies. Land resources: Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification Role of individual in conservation of natural resource
Block IV	**Social issues and the Environment** From unsustainable to sustainable development; Urban problems related to energy Water conservation, rain water harvesting, watershed management Environmental ethics: Issues and possible solutions Climate change, global warming, acid rain, ozone layer depletion and nuclear accidents. Environment protection Act; Air (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act Issues involved in enforcement of environmental legislation; Public awareness
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc
Text books	1. Agarwal, K. C. 2001. Environmental Biology, Nidhi Publications Ltd. Bikaner. 2. Bharucha, E. 2005. Textbook of Environmental Studies, Universities Press, Hyderabad. 3. Bharucha, E. 2004. The Biodiversity of India, Mapin Publishing Pvt. Ltd. Ahmedabad. 4. Brunner, R. C. 1989. Hazardous Waste Incineration, McGraw Hill Inc. New York. 5. Clark, R. S. 2000. Marine Pollution, Clanderson Press Oxford. 6. Cunningham, W. P., Cooper, T. H., Gorhani, E. & Hepworth, M. T. 2001. 7. Environmental Encyclopedia, Jaico Publications House, Mumbai.Management," Excel books, New Delhi 2011

Course Code **DBSPSE101T24**	**Chemiinformatics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand about the uses of cheminformatics in structure elucidation.	
CO 2	Explain, interpret and critically examine the utility of computers and software tools to solving chemistry related problems.	
CO 3	Recognize, apply, compare and predict chemical structures, properties, and reactivity and; solve chemistry related problems.	
CO 4	Synthesized the structure of pharmaceutical compounds.	
CO 5	Appreciate role of modern computation techniques in the drug discovery process and perform their own modelling studies.	
CO 6	Predict the spectra of compound for the confirmation.	
Course Content		
Block I	**Introduction to Cheminformatic**s History and evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modelling and Structure elucidation.	
Block II	**Representation of molecules and chemical reactions** Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and SD files, Libraries and toolkits, Different electronic effects, Reaction classification	
Block III	**Searching chemical structures** Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.	
Block IV	**Applications** Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatic in Drug Design.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. Leach, A. R.; Gillet, V. J. (2007), An introduction to Chemoinformatic, Springer. 2. Gasteiger, J.; Engel, T. (2003), Chemoinformatic: A text-book. Wiley-VCH. 3. Gupta, S. P. (2011),QSAR& Molecular Modeling. Anamaya Pub. *4.* Gasteiger, J. Handbook of cheminformatics: from data to knowledge in 4 volumes, Wiley. Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Chemoinformatic.* Springer: The Netherlands. *5.* Gasteiger, J. & Engel, T. (2003) *Chemoinformatic: A text-book.* Wiley-VCH. *6.* Gupta, S. P. (2011) *QSAR & Molecular Modeling.* Anamaya Pub.: New Delhi *7.* Robert M. Silverstein, Franics X. Webster. Spectrometric Identification of Organic Compounds, 8th Edition, WILEY

II Semester

Course Code **DBSPCO201T24**	**Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand the laws of thermodynamics, thermo chemistry and equilibria.	
CO 2	Understand concept of pH and its effect on the various physical and chemical properties of the compounds.	
CO 3	Predict the pH of buffer salts.	
CO 4	Apply the concepts learnt to predict feasibility of chemical reactions and to study the behavior of reactions in equilibrium.	
CO 5	Understand the fundamentals of functional group chemistry through the study of methods of preparation, properties.	
CO 6	Create mechanism for chemical reactions with underlying mechanism.	
Course Content		
Block I	**Chemical Energetics** Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.	

Block II	**Chemical Equilibrium and Ionic Equilibria:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between Δ*G* and Δ*G*o, Le Chatelier's principle. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases. Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffers solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.
Block III	**Aromatic hydrocarbons** Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene). **Alkyl and Aryl Halides** Alkyl Halides (Up to 5 Carbons), Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution. Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 or $NaNH_2/NH_3$. Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
Block IV	**Alcohols, Phenols, Ethers and Carbonyl compounds (Up to 5 Carbons)** Alcohols: Preparation: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement. Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben– Hoesch Condensation, Schotten – Baumann Reaction. Ethers (aliphatic and aromatic): Cleavage of ethers with HI. Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc

Text books	1. Castellan, G. W. (2004),Physical Chemistry, Narosa. 2. Kapoor, K.L. (2015),A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education. 3. Kapoor, K.L.(2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education. 4. B.R. Puri, L.R. Sharma, M.S. Pathania, (2017),Principles of Physical Chemistry, Vishal Publishing Co. 5. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 6. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Page 12 of 96 B.Sc. Physical Science 7. Bahl, A; Bahl, B. S. (2012), Advanced Organic Chemistry, S. Chand. 8. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. 9. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

Course Code **DBSPCO202T24**	**Optics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand interaction of light with matter through interference, diffraction and polarization.	
CO 2	Measure the wave length and refractive index.	
CO 3	Find the wavelength of spectral lines using plane diffraction grating,	
CO 4	Distinguish ordinary light with a laser light and to realize propagation of light through optical fibers.	
CO 5	Can compare the different area of application of optical fibers.	
CO 6	Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers.	
Course Content		
Block I	**Interference** Division of amplitude and wave front. Young's double slit experiment. Fresnel's Biprism, Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Newton's Rings: Measurement of wavelength and refractive index. 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.	
Block II	**Diffraction** Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit, Multiple slits. Diffraction grating. Resolving power of grating. 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.	
Block III	**Polarization** Double refraction and optical rotations: Double refraction in uniaxial crystals, explanation in terms of electromagnetic theory, Malus Law, Phase retardation plates, rotation of plane of polarization, origin of optical rotation in liquids and in crystals, Measurement of Specific rotation of a cane sugar solution using a Half Shade and a biquartz device polarimeter.	

Block IV	**Laser & Optical Fiber** Lasers: Laser theory, Light Amplification, threshold condition, Properties of Lasers, Spontaneous and Stimulated emissions, Laser Rate Equations, Einstein's A and B coefficients, two, three and four level systems. Optical Pumping, Population Inversion, Ruby Laser, He-Ne Laser and semiconductor laser. Applications of laser. Optical Fiber: Elementary idea of optical fibers, Step Index (Single mode and Multi-mode) and Graded Index Optical Fiber, Light propagation through optical fiber, Acceptance angle and Numerical aperture of an optical fiber, Applications of Optical Fiber.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill. 2. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill 3. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons. 4. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill. 5. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

Course Code **DBSPCO203T24**	**Differential Equation**	**C-4**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Distinguish between linear, nonlinear, partial and ordinary differential equations.	
CO 2	Recognize and solve a variable separable differential equation, homogeneous differential equation.	
CO 3	Solve the exact differential equation, linear differential equation by use of an integrating factor.	
CO 4	Recognize and solve equations of Bernoulli, Ricatti and Clairaut.	
CO 5	Calculate particular solutions to initial value problems.	
CO 6	Solving the Vibrating String Problem, Solving the Heat Conduction problem.	
Course Content		
Block I	Differential equations: Order and degree. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and trans formations. Basic theory of linear differential equations, Linear Differential equation o higher order with constant coefficient, Complimentary function and particular integral. Homogeneous linear differential equations. Simultaneous differential equations. Wronskian, its properties and applications	
Block II	Linear homogenous equations with constant coefficients, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations. Solving a differential equation by reducing its order. Second order ordinary Differential equations with variable coefficients: Homogeneous and exact form, one part of C.F. is known, Normal form, change of independent variable, Method of variation of parameter	
Block III	Order and degree of partial differential equations, Concept of linear and non- linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method Classification of second order partial differential equations into elliptic, parabolic and hyperbolic, Derivation of Heat equation, Wave equation and Laplace equation.	
Block IV	The Cauchy problem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary condition. Non-Homogeneous Wave Equation. Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. M.D. Raisinghania, 1989 (First Edition), "Differential Equation", S Chand Publication,New Delhi. 2. Rakesh Agarwal, 2010 (First Edition), "Engineering Mathematics" Vayu Education of India, New Delhi. 3. Gupta, Malik, Mittal, 1982 (First Edition)"Differential Equations", Pragti Prakashan, Meerut. 4. Bansal and Dhami, Volume I , II, 1992 (First Edition), "Differential Equations", Jaipur Publishing House, Jaipur. 5. M. Roy and J.C Chaturvedi,1990 (First Edition) "A text Book of Differential equations", Student Friends and Co. Publisher, Agra.

Course Code **DBSPCO201P24**	**Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Measure the heat capacity of calorimeter, enthalpy of neutralization, enthalpy of ionization, integral enthalpy of solution, enthalpy of hydration and solubility of benzoic acid in water and determination of ΔH.	
CO 2	Perform titration for Measurement of pH of different solutions.	
CO 3	Demonstrate Different Process for Purification of organic compounds like crystallization and recrystallization and determination of melting and boiling points.	
CO 4	Create the Preparations of various reactions involved Bromination, Benzoylation, Oxime and 2, 4-dinitrophenylhydrazone.	
CO 5	Perform the synthesis of different buffer solution.	
Exercises		
Section A: Physical Chemistry		
Exercise 1.	Thermochemistry Determination of heat capacity of calorimeter for different volumes.	
Exercise 2.	Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	
Exercise 3.	Determination of enthalpy of ionization of acetic acid.	
Exercise 4.	Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).	
Exercise 5.	Determination of enthalpy of hydration of copper sulphate.	
Exercise 6.	Study of the solubility of benzoic acid in water and determination of Δ*H*.	
Exercise 7.	pH measurements Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.	
Exercise 8.	Preparation of buffer solutions: a. Sodium acetate-acetic acid b. Ammonium chloride-ammonium hydroxide	
Exercise 9.	Measurement of the pH of buffer solutions and comparison of the values with theoretical values.	
Section B: Organic Chemistry		
Exercise 10.	Purification of organic compounds by crystallization (from water and alcohol) and distillation.	
Exercise 11.	Criteria of Purity: Determination of melting and boiling points.	
Exercise 12.	Preparations: Mechanism of various reactions involved to be discussed.	
Exercise 13.	Recrystallisation, determination of melting point and calculation of quantitative yields to be done. a. Bromination of Phenol/Aniline b. Benzoylation of amines/phenols oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone	

Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). 2. Mahan, B. H. (2013),University Chemistry, Narosa. 3. Barrow, G.M. (2006). Physical Chemistry, 5th Edition, McGraw Hill.

Course Code **DBSPCO202P24**	**Optics lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	To follow the principles of measurement and error analysis.	
CO 2	To develop skills in experimental design.	
CO 3	To calibrate the wave length of sodium lamp.	
CO 4	To Measure the dispersive power of materials.	
CO 5	To demostrate the intensity using photosensor and laser in diffraction patterns of single and double slits.	
Exercises		
Exercise 1.	To investigate the motion of coupled oscillators (a)Frequency Splitting (b) Energy Transfer	
Exercise 2.	To determine the Refractive Index of the Material of a Prism using Sodium Light.	
Exercise 3.	To determine Dispersive Power of the Material of a Prism using Mercury Light	
Exercise 4.	To determine the value of Cauchy Constants.	
Exercise 5.	To determine the Resolving Power of a Prism.	
Exercise 6.	To determine wavelength of sodium light using Newton's Rings.	
Exercise 7.	To determine the wavelength of Laser light using Diffraction grating.	
Exercise 8.	To determine wavelength of spectral lines of the Mercury light using plane diffraction Grating	
Exercise 9.	To determine the Resolving Power of a Plane Diffraction Grating.	
Exercise 10.	To determine wavelength of sodium light using Fresnel Biprism.	
Exercise 11.	To determine the Resolving Power of a telescope.	
Exercise 12.	To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.	
Exercise 13.	To determine pitch of a scale using He-Ne Laser	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House. 2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers	

Course Code **DBSPDS201T24**	**Database Management System**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Differentiate database systems from file systems by enumerating the features provided by database systems.	
CO 2	Describe each in both function and benefit.	
CO 3	Analyze an information storage problem.	
CO 4	Drive an information model expressed in the form of an entity relation diagram and other optional analysis forms, such as a data dictionary.	
CO 5	Assess Multilevel indexing using B and B+ trees.	
CO 6	Develop the File Structure and Indexing.	
Course Content		
Block I	**Introduction** Characteristics of database approach, data models, database system architecture and data independence. Entity Relationship (ER) Modeling Entity types, relationships, constraints. Relation data model, Relational model concepts, relational constraints, relational algebra, SQL queries	
Block II	**Database design** Database design, Mapping ER/EER model to relational database, functional dependencies, Lossless decomposition, Normal forms(up to BCNF).Transaction Processing	
Block III	**File Structure and Indexing** ACID properties, concurrency control, File Structure and Indexing	
Block IV	**Operations on files** Operations on files, File of Unordered and ordered records, overview of File organizations, Indexing structures for files(Primary index, secondary index, clustering index), Multilevel indexing using B and B+ trees	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. R. Elmasri, S.B. Navathe, Fundamentals of Database Systems 6th Edition, Pearson Education, 2010. 2. R. Ramakrishanan, J. Gehrke, Database Management Systems 3rd Edition, McGraw -Hill, 2002. 3. Silberschatz, H.F. Korth, S. Sudarshan, Database System Concepts 6th Edition, McGraw Hill, 2010. 4. R. Elmasri, S.B. Navathe Database systems Models, Languages, Design and application Programming, 6th Edition, Pearson Education, 2013.	

Course Code **DBSPDS202T24**	**Information Security**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define what information is appreciate the value of information to the modern organization.	
CO 2	Understand the CIA triad of Confidentiality, Integrity and Availability.	
CO 3	Analyze the difficulties that arise when valuable information needs to be shared.	
CO 4	Identify the five leading-edge resources that have up-to-date information on information security.	
CO 5	Evaluate the Cryptography Substitution, transposition ciphers, symmetric.	
CO 6	Develop Security Mechanisms for Intrusion detection, auditing and logging, tripwire, system-call monitoring.	
Course Content		
Block I	**Overview of Security** Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication, Orange Book.	
Block II	Security Threats Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats- intruders; communication threats- tapping and piracy.	
Block III	**Cryptography** Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.	
Block IV	**Digital signatures** Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures. Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. W. Stallings, Cryptography and Network Security Principles and Practices, 4th Ed., Prentice-Hall of India, 2006. 3. C. Pfleeger and S.L. Pfleeger, Security in Computing, 3rd Ed., Prentice-Hall of India, 2007. 3. D. Gollmann, Computer Security, John Wiley and Sons, NY, 2002. 4. J. Piwprzyk, T. Hardjono and J. Seberry, Fundamentals of Computer Security, Springer-Verlag Berlin, 2003. 5. J.M. Kizza, Computer Network Security, Springer, 2007. 6. M. Merkow and J. Breithaupt, Information Security: Principles and Practices, Pearson Education, 2006.

Course Code **DBSPDS201P24**	**Database Management System lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow database concepts and structures and query language.	
CO 2	To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.	
CO 3	Demonstrate Functional Dependency and Functional Decomposition.	
CO 4	Perform PL/SQL programming using concept of Cursor Management, Error Handling, Package and Triggers.	
CO 5	Execute various advance SQL queries related to Transaction Processing & Locking using concept of Concurrency control.	
Exercises		
Exercise 1.	Create a database having two tables with the specified fields, to computerize a library system of a Delhi University College. Library Books (Accession number, Title, Author, Department, Purchase Date, Price) Issued Books (Accession number, Borrower) 1. Identify primary and foreign keys. Create the tables and insert at least 5 records in each table 2. Delete the record of book titled —Database System Concepts‖. 3. Change the Department of the book titled —Discrete Maths‖to —CS‖. 4. List all books that belong to —CS‖ department. 5. List all books that belong to —CS‖department and are written by author —Navathe‖. 6. List all computer (Department=‖CS‖) that have been issued. 7. List all books which have a price less than 500 or purchased between —01/01/1999‖and —01/01/2004	
Exercise 2.	Create a database having three tables to store the details of students of Computer Department in your college. Personal information about Student (College roll number, Name of student, Date of birth, Address, Marks(rounded off to whole number) in percentage at 10 + 2, Phone number) Paper Details (Paper code, Name of the Paper)Student's Academic and Attendance details (College roll number, Paper code, Attendance, Marks in home examination). 1. Identify primary and foreign keys. Create the tables and insert at least 5 records in each table. 2. Design a query that will return the records (from the second table) along with the name of student from the first table, related to students who have more than 75% attendance and more than 60% marks in paper 2. 3. List all students who live in —Delhi‖ and have marks greater than 60 in paper. 4. Find the total attendance and total marks obtained by each student. 5. List the name of student who has got the highest marks in paper 2.	

Exercise 3.	Create the following tables and answer the queries given below: Customer (Cust ID, email, Name, Phone, Referrer ID) Bicycle (Bicycle ID, Date Purchased , Color, CustID, Model No) Bicycle Model (ModelNo, Manufacturer, Style)Service (StartDate, BicycleID, End Date). 1. Identify primary and foreign keys. Create the tables and insert at least 5 records in each table 2. List all the customers who have the bicycles manufactured by manufacturer —Honda‖. 3. List the bicycles purchased by the customers who have been referred by customer —C1‖. 4. List the manufacturer of red colored bicycles. 5. List the models of the bicycles given for service.
Exercise 4.	Create the following tables, enter at least 5 records in each table and answer the queries given below.EMPLOYEE(Person_Name, Street, City)WORKS (Person_Name, Company_Name, Salary) COMPANY (Company_Name, City)MANAGES (Person_Name, Manager_Name) 1. Identify primary and foreign keys 2. Alter table employee, add a column —email‖ of type varchar (20). 3. Find the name of all managers who work for both Samba Bank and NCB Bank. 4. Find the names, street address and cities of residence and salary of all employees who work for —Samba Bank‖ and earn more than $10,000. 5. Find the names of all employees who live in the same city as the company for which they work. 6. Find the highest salary, lowest salary and average salary paid by each company. 7. Find the sum of salary and number of employees in each company. Find the name of the company that pays highest salary
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Database System Concepts, Textbook by Avi Silberschatz, Henry F. Korth, and S. Sudarshan. 2. SQL, PL/SQL: The Programming Language of Oracle, IvanByross. 3. An Introduction to Database Systems, Desai Bipin C.

Course Code **DBSPDS202P24**	**Information Security lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Formulate information security governance, and related legal and regulatory issues.	
CO 2	Devices how threats to an organization are discovered, analyzed, and dealt with.	
CO 3	Evaluate network security threats and countermeasures.	
CO 4	Construct network security designs using available secure solutions (such as PGP, SSL, IPSec, etc)	
CO 5	Acquire the knowledge of advanced security issues and technologies (such as DDoS attack detection and containment, and anonymous communications)	
Exercises		
Exercise 1.	Data Encryption techniques and Hashing.	
Exercise 2.	Data Encryption techniques and Hashing.	
Exercise 3.	Data Encryption techniques and Hashing.	
Exercise 4.	Data Encryption techniques and Hashing.	
Exercise 5.	Data Encryption techniques and Hashing.	
Exercise 6.	Data Encryption techniques and Hashing.	
Exercise 7.	Data Encryption techniques and Hashing.	
Exercise 8.	Data Encryption techniques and Hashing.	
Exercise 9.	Antivirus installation	
Exercise 10.	Password management	
Exercise 11.	User Account Control (Windows)	
Exercise 12.	Firewall and Router setting	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. W. Stallings, Cryptography and Network Security Principles and Practices, 4th Ed., Prentice-Hall of India, 2016. 2. C. Pfleeger and S.L. Pfleeger, Security in Computing, 3rd Ed., Prentice-Hall of India, 2017.	

Course Code **DBSPAE201T24**	**English**	**C-2**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Recall the abilities to express their feelings with proper vocabulary and pronunciation as well as write clearly, grammatically and syntactically correct sentences.	
CO 2	Illustrate the texts closely and explicate texts written in a wide variety of forms, styles, structures, and modes.	
CO 3	Determine students in achieving their career and lifelong goals by exhibiting balanced professional attitude in every walk of life.	
CO 4	Compare and contrast primary and secondary documents, and advance their reading comprehension.	
CO 5	Conclude the Persuade and convince.	
CO 6	Develop the English language with propriety and effectiveness to develop an argument in a positive manner as well as develop acquaintance to various aspects to the fullest.	
Course Content		
Block I	**Grammatical Focus**: Grammatical & Structural aspects covering Parts of Speech, Tense, Voice, Clause, Preposition, Degrees of Comparison, Synonyms & Antonyms, etc, Identifying & Analyzing Grammatical Errors including errors in Spelling & Punctuation.	
Block II	**Reading** : Vocabulary Building; Comprehension; Interpretation; Summarizing	
Block III	**Writing :** Letter Writing – Formal, Informal; Accepting & Declining Invitations; Paragraph Writing, Precise Writing, Essay Writing	
Block IV	**Speaking :** Interactive Communication like Introducing Self, Greetings, Conversations, etc, Pronunciation : appropriate stress, intonation, clarity .Listening : Understanding – Spoken English, Formal English; Exercises	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Leo Jones, Richard Alexander: New International Business English (Communication Skills in English for Business Purposes), Cambridge University Press. 2. NCERT, Knowing about English – A Book of Grammar& Phonology National Building Code of India, Bureau of Indian Standards, New Delhi, 1999 3. NCERT, Working with English – A Workbook, A.E. Augustine & K.V. Joseph : 4. Macmillan Grammar – A Handbook, Macmillan 5. Krishna Mohan & N.P. Singh : Speaking English Effectively, Macmillan 6. Kulbhushan Kumar, Effective Communication Skills, Khanna Publishing House, New Delhi	

Course Code **DBSPSE201T24**	**Mathematical Physics-I**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Learn the basic elements of complex analysis, including the important integral theorems.	
CO 2	Understand to expand a function in a Fourier series, and under what conditions such an expansion is valid.	
CO 3	Apply use of Fourier and Laplace transformations to solve differential equations.	
CO 4	Analyze mathematical problems arising in physics by a variety of mathematical techniques.	
CO 5	Training in calculus will prepare the student to solve various mathematical problems.	
CO 6	Create an understanding of how to formulate a physics problem and solve given mathematical equation risen out of it.	
Course Content		
Block I	**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. Parseval Identity.	
Block II	**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 and Orthogonality.	
Block III	**Special Integrals**: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.	
Block IV	**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.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier. 2. Fourier analysis by M.R. Spiegel, 2004, Tata McGraw-Hill. 3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole. 4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill	

Exit option with Certificate in Physical Sciences

* Credits of Open Elective courses can be obtained from MOOC and SWAYAM courses

III-Semester

Course Code **DBSPCO301T24**	**Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Explain the concepts of different types of binary solutions-miscible, partially miscible and immiscible along with their applications.	
CO 2	Explain the thermodynamic aspects of equilibria between phases and draw phase diagrams of simple one component and two component systems.	
CO 3	Explain the factors that affect conductance, migration of ions and application of conductance measurement.	
CO 4	Understand different types of galvanic cells, their Nernst equations, and measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements.	
CO 5	Understand and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.	
CO 6	Design newer synthetic routes for various organic compounds	
Course Content		
Block I	**Solutions and Phase Equilibrium** Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. Phase Equilibrium: Phases, components and degrees of freedom of a system, criteria of Phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, FeCl3H2O and Na-K only).	

Block II	**Conductance and Electrochemistry** Conductance Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base). Electrochemistry Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes .Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).
Block III	**Carboxylic acids, its derivatives and Amines** Carboxylic acids (aliphatic and aromatic) Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Volhard - Zelinsky Reaction. Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation. Amines and Diazonium Salts Amines (Aliphatic and Aromatic): (Up to 5 carbons) Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.
Block IV	**Amino Acid and Carbohydrates** Amino Acids, Peptides and Proteins: Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edman degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme).Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxy carbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis. Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Text books	1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill. 2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press. 3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications. 4. Heat and Thermodynamics, M.W. Zemasky and R. Dittman, 1981, McGraw Hill 5. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears &G.L. Salinger. 1988, Narosa 6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. 7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Course Code **DBSPCO302T24**	**Thermodynamics and Statistical Physics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand the role of internal energy, enthalpy, temperature, pressure, and specific volume thermodynamic properties.	
CO 2	Elucidate the basics of Carnot cycle, statistics and distributions.	
CO 3	Explain the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws.	
CO 4	Analyze important examples of ideal Bose systems and Fermi systems.	
CO 5	Compare the Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy.	
CO 6	Draw the Clausius Clapeyron Equation and Herrin Festa equations.	
Course Content		
Block I	**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. 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, 2nd 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.	
Block II	**Entropy & Thermodynamic Potentials** 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. 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	

Block III	**Classical Statistics & Theory of Radiation** Classical Statistics: Macro state & 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. 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.
Block IV	**Bose-Einstein & Fermi-Dirac Statistics** Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. 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.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill. 2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press. 3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications. 4. Heat and Thermodynamics, M.W. Zemasky and R. Dittman, 1981, McGraw Hill 5. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears &G.L. Salinger. 1988, Narosa 6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. 7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Course Code **DBSPCO303T24**	**Real Analysis**	**C-4**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis.	
CO 2	Comprehend rigorous arguments developing the theory underpinning real analysis.	
CO 3	Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.	
CO 4	Construct rigorous mathematical proofs of basic results in real analysis.	
CO 5	Appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.	
CO 6	Recognize a geometric series and correctly apply the convergence theorem.	
Course Content		
Block I	Algebraic and order properties of R, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of R.	
Block II	The completeness property of R, Archimedean property, Density of rational numbers in R; Definition and types of intervals, Nested intervals property; Neighborhood of a point in R , Open and closed sets in R.	
Block III	Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's convergence criterion.	
Block IV	Convergence and divergence of infinite series of real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series: Integral test, Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test; Alternating series, Leibniz test, Absolute and conditional convergence.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003. 2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004. 3. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999. 4. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.	

Course Code **DBSPCO301P24**	**Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Construction of phase diagram of different component system.	
CO 2	Perform of conductometric and pH metric titrations.	
CO 3	Demonstrate systematic Qualitative organic analysis.	
CO 4	Manage the handling of different types of chromatography for separation and identification.	
CO 5	Organize the instrumentation for quantitative and qualitative determination.	
Exercises		
Exercise 1.	Distribution Study of the equilibrium of one of the following reactions by the distribution method: $I_2(aq) + I^-(aq) \rightarrow I_3^-(aq)$ $Cu^{2+}(aq) + xNH_2(aq) \rightarrow [Cu(NH_3)x]^{2+}$	
Exercise 2.	Phase equilibria: Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.	
Exercise 3.	Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.	
Exercise 4.	Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.	
Exercise 5.	Conductance I. Determination of cell constant	
Exercise 6.	II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.	
Exercise 7.	III. Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base	
Exercise 8.	Potentiometry Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Potassium dichromate vs. Mohr's salt	
Exercise 9.	Systematic Qualitative Organic Analysis of Organic Compounds possessing mono functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.	
Exercise 10.	Separation of amino acids by paper chromatography	
Exercise 11.	Determination of the concentration of glycine solution by formylation method.	
Exercise 12.	Titration curve of glycine	
Exercise 13.	Action of salivary amylase on starch	
Exercise 14.	Effect of temperature on the action of salivary amylase on starch.	
Exercise 15.	Differentiation between a reducing and a non-reducing sugar.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. Khosla, B.D., Garg, V.C. Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & CoVogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996. 2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960. 3. Khosla, B. D. Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011). 4. Ahluwalia, V.K. &Aggarwal, R. *Comprehensive Practical Organic* b *Chemistry*, Universities Press.

Course Code **DBSPCO302P24**	**Thermodynamics and Statistical Physics Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Measurement of thermal conductivity, surface tension, See beck coefficients.	
CO 2	Plot Planck's law for Black Body radiation and compare it with Wein's Law.	
CO 3	Calibrate Maxwell-Boltzmann distribution function versus temperature.	
CO 4	Formulate C/C++/ Scilab / MATLAB for solving the problems based on Statistical Mechanics.	
CO 5	Develop Plot Bose-Einstein distribution function versus temperature.	
Exercises		
Exercise 1.	Use C/C++/ Scilab / MATLAB for solving the problems based on Statistical Mechanics.	
Exercise 2.	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	
Exercise 3.	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	
Exercise 4.	Plot Maxwell-Boltzmann distribution function versus temperature.	
Exercise 5.	Plot Fermi-Dirac distribution function versus temperature.	
Exercise 6.	Plot Bose-Einstein distribution function versus temperature.	
Exercise 7.	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	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House 2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal 3. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers 4. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.	

Course Code **DBSPDS301T24**	**Digital Systems and Applications**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Recall the concept linear modeling of passive elements and sources.	
CO 2	Demonstrate analytical techniques in resistive circuits energized by direct current voltage and current sources.	
CO 3	Determine the logic gates using diodes and transistors.	
CO 4	Analyze concepts of combinational logic circuits and sequential circuits.	
CO 5	Evaluate Sequential systems by choosing Flip Flop as a building bock- construct multi vibrators, counters to provide a basic idea about memory.	
CO 6	Develop Synthesis of Boolean functions, simplification and construction of digital circuits by employing Boolean algebra.	
Course Content		
Block I	**CRO & IC's** 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. 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 IC's.	
Block II	**Intel 8085 Microprocessor** Timers: IC 555: block diagram and applications: A stable multivibrator and Monostable multivibrator. Computer Organization: Input/ Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. 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. Introduction to Assembly Language: 1 byte, 2 bytes & 3-byte instructions.	
Block III	**Digital Circuits & Boolean Algebra** 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. Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Min terms and Max terms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	

Block IV	**Sequential Circuits** Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half& Full Subtractors, 4-bit binary Adder/ Subtractor. 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. Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. 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).
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw 2. Fundamentals of Digital Circuits, Anand Kumar, 2ndEdn, 2009, PHI Learning Pvt. Ltd. 3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. 4. Digital Electronics G K Kharate ,2010, Oxford University Press 5. Digital Systems: Principles & Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning 6. Logic circuit design, Shimon P. Vingron, 2012, Springer. 7. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

Course Code DBSPDS302T24	Instrumental Methods of Analysis	C-3
Course Outcomes	After completion of this course, a student will be:	
CO 1	Measurement of different analytical data.	
CO 2	Execute IR, FTIR, U.V-Visible and Mass spectrometer for data analysis.	
CO 3	Interpret of IR, FTIR, UV-visible spectra and their applications.	
CO 4	Adapt the use of single and double beam instruments and Electroanalytical Methods, Radiochemical Methods.	
CO 5	Develop different separations techniques like Chromatography.	
Course Content		
Block I	**Introduction to spectroscopic methods of analysis**: Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.	
Block II	**Molecular spectroscopy**: Infrared spectroscopy: Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.	
Block III	**UV-Visible/ Near IR and Mass spectroscopy** UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags). Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).	
Block IV	**Mass, NMR and Atomic Spectroscopy** Elemental analysis: Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences). NMR spectroscopy: Principle, Instrumentation, Factors affecting chemical shift, Spin-coupling	

Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, F.A. Jr.(2004), Instrumental methods of analysis, 7th edition, CBS Publishers. 2. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley & Sons, New York. 3. Skoog, D.A.; Holler, F. J.; Crouch, S.(2006),Principles of Instrumental Analysis,Thomson Brooks/Cole. 4. Banwell, C.N. (2006),Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Education 5. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988. 6. Robert M. Silverstein, Franics X. Webster. Spectrometric Identification of Organic Compounds, 8th Edition, WILEY

Course Code **DBSPDS303T24**	**Partial Differential Equation**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define the partial differential equations (PDEs), modeling, the general structure of solutions, and analytic and numerical methods for solutions.	
CO 2	Formulate physical problems as PDEs using conservation laws.	
CO 3	Understand analogies between mathematical descriptions of different (wave) phenomena in physics and engineering.	
CO 4	Classify PDEs, apply analytical methods, and physically interpret the solutions.	
CO 5	Solve practical PDE problems with finite difference methods, implemented in code, and analyze the consistency, stability and convergence properties of such numerical methods.	
CO 6	Interpret solutions in a physical context, such as identifying travelling waves, standing waves, and shockwaves.	
Course Content		
Block I	**Partial Differential Equations**–Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations	
Block II	Derivation of Heat equation, Wave equation and Laplace equation Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.	
Block III	The Cauchy problem, the Cauchy-Kovalevskaya theorem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non- homogeneous boundary conditions, Non-Homogeneous Wave Equation. Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem	
Block IV	Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. TynMyint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint,2006. 2. S.L.Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004. 3. Martha L Abell, James P Braselt on, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press,2004.	

Course Code **DBSPDS301P24**	**Digital Systems and Applications Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow important types of integrated circuits.	
CO 2	Demonstrate the ability to design practical circuits that perform the desired operations.	
CO 3	Organize differences between theoretical, practical & simulated results.	
CO 4	Build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates and using Flip-Flop ICs in integrated circuits.	
CO 5	Design the programs using 8085 Microprocessor like Addition and subtraction of numbers using direct addressing mode and indirect addressing mode.	
Exercises		
Exercise 1.	To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.	
Exercise 2.	To test a Diode and Transistor using a Multimeter.	
Exercise 3.	To design a switch (NOT gate) using a transistor.	
Exercise 4.	To verify and design AND, OR, NOT and XOR gates using NAND gates.	
Exercise 5.	To design a combinational logic system for a specified Truth Table.	
Exercise 6.	To convert a Boolean expression into logic circuit and design it using logic gate ICs.	
Exercise 7.	To minimize a given logic circuit.	
Exercise 8.	Half Adder, Full Adder and 4-bit binary Adder.	
Exercise 9.	Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.	
Exercise 10.	To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.	
Exercise 11.	To build JK Master-slave flip-flop using Flip-Flop ICs	
Exercise 12.	To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.	
Exercise 13.	To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.	
Exercise 14.	To design an a stable multivibrator of given specifications using 555 Timer.	
Exercise 15.	To design a monostable multivibrator of given specifications using 555 Timer.	
Exercise 15.	Write the following programs using 8085 Microprocessor	
Exercise 16.	Addition and subtraction of numbers using direct addressing mode	
Exercise 17.	Addition and subtraction of numbers using indirect addressing mode	
Exercise 18.	To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill. 2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill. 3. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.	

Course Code **DBSPDS302P24**	**Instrumental Methods of Analysis lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Measure the properties of different biomolecules.	
CO 2	To perform separations techniques like Chromatography.	
CO 3	Adapt techniques use elemental analysis, NMR spectroscopy, Electroanalytical Methods, Radiochemical Methods, X-ray analysis and electron spectroscopy.	
CO 4	Perform different methods use in identification of compounds.	
CO 5	Develop the method for determination of drugs.	
Exercises		
Exercise 1.	Safety Practices in the Chemistry Laboratory	
Exercise 2.	Determination of the isoelectric pH of a protein.	
Exercise 3.	Titration curve of an amino acid.	
Exercise 4.	Determination of the void volume of a gel filtration column.	
Exercise 5.	Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)	
Exercise 6.	Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)	
Exercise 7.	IR Absorption Spectra (Study of Aldehydes and Ketones)	
Exercise 8.	Determination of Calcium, Iron, and Copper in Food by Atomic Absorption	
Exercise 9.	Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)	
Exercise 10.	Separation of Carbohydrates by HPLC	
Exercise 11.	Determination of Caffeine in Beverages by HPLC	
Exercise 12.	Potentiometric Titration of a Chloride-Iodide Mixture	
Exercise 13.	Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple	
Exercise 14.	Use of “presumptive tests” for anthrax or cocaine	
Exercise 15.	Collection, preservation, and control of blood evidence being used for DNA testing	
Exercise 16.	Laboratory analysis to confirm anthrax or cocaine	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Skoog, D. A.; Holler, F. J.; Crouch, S.(2006),Principles of Instrumental Analysis, Cengage Learning. 2. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, F.A. Jr.(2004), Instrumental methods of analysis, 7th edition, CBS Publishers. 3. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed. 4. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA.	

Course Code **DBSPDS303P24**	**Partial Differential Equation Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Measure analogies between mathematical descriptions of different (wave) phenomena in physics and engineering.	
CO 2	Classify PDEs, apply analytical methods, and physically interpret the solutions.	
CO 3	Solve practical PDE problems with finite difference methods, implemented in code.	
CO 4	Analyze the consistency, stability and convergence properties of such numerical methods.	
CO 5	Interpret solutions in a physical context, such as identifying travelling waves, standing waves, and shockwaves.	
Exercises		
Exercise 1.	Solution of Cauchy problem for first order PDE.	
Exercise 2.	Finding the characteristics for the first order PDE.	
Exercise 3.	Plot the integral surfaces of a given first order PDE with initial data. Solution of wave equation	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. TynMyint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006. 2. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004. 3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.	

Course Code **DBSPAE301T24**	**Professional communication Skills**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	To Understand the process of communication and its effect on giving and receiving information	
CO 2	To Learn about historical and theoretical developments in the field of communication	
CO 3	Apply effective communication skills in a variety of public and interpersonal settings	
CO 4	Able to preparing for the interview, style of interview and Group discussion.	
CO 5	To Develop Coherence, Cohesion and Competence in Oral Discourse through Intelligible Pronunciation.	
CO 6	Ability to handle the interview process confidently.	
Course Content		
Block I	**Communication** Definition, barriers in communications, implication of communication, purpose of communication. Elements: Preparation, structure and personal interaction.	
Block II	**Oral Communication** Skill and techniques of Speaking, preparation of Speaking, Development of speaking skills, and barriers to speaking, speaking structure, bridging points, time limitation/length of speech, Use of Humor. Visual Communication: Nature and scope of visual aids, Bolds, slides, overhead projector, cutouts.	
Block III	**Technical letter writing Visual Communication** Technical letter writing: Purpose of writing, space/layout, economy of words, use of verb/passive voice, type face (italics, bold, underline) and use of indentation. Report writing: Preparation, report structure (purpose of report, scope, shape, presentation of report, introduction of report, bridging of report, style of report, and index of report.	
Block IV	**Public communication** Public communication: meetings, planning and discussion, opening procedure, timing, degree of formality, behavior, repetitive, Interviews (complexity of situation, preparation of thinking, preparation of setting, preparing the interview, style of interview).Group discussion. (to enhance oral communication and debates, speeches; addresses may be introduced for Public).	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Abelow, Daniel, Hilpert Edusin J. 1986 Communications in the Modern Corporate Environment, Prentice Hall, Englewood Cleffs. 2. Colay Jay, Communication Skills, PBS Publishers and Distributors, Bhopal. 3. Rao N. and Das R. P. 2007 Himalaya Publication. 4. Krishna M. and Banerji M., 1990 MacMillan. 5. Methew M.M. ,1997 The Craft of Business Letter Writing, Tata McGraw-Hill	

Course Code DBSPSE301T24	GREEN METHODS IN CHEMISTRY	C-3
Course Outcomes	After completion of this course, a student will be:	
CO 1	Explain the need and scope of green chemistry.	
CO 2	Understand and apply knowledge of the common metrics used in Green Chemistry applications.	
CO 3	Apply knowledge of introductory green chemical synthetic methods, choice of solvents, atom economy, and sustainable raw materials.	
CO 4	Solve the problems by numerical methods.	
CO 5	Analyze how to use solvent selection for pollution prevention	
CO 6	Develop and demonstrate knowledge pertaining to the background and development of Green Chemistry.	
Course Content		
Block I	**Introduction to Green Chemistry** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Tools of Green chemistry .Limitations/ Obstacles in the pursuit of the goals of Green Chemistry **Principles of Green Chemistry and Designing a Chemical synthesis :** Twelve principles of Green Chemistry with their explanations and examples	
Block II	**Green chemistry in real world cases** **The following Real world Cases in Green Chemistry should be discussed:** Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis) 2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) 4. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments. 5. Designing of Environmentally safe marine anti-foulant. 6. Right fit pigment: synthetic azo pigments to replace toxic organic and inorganic pigments. 7. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. 8. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils 9. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting	

Block III	**Pollution Prevention** New Green and sustainable synthetic methods. An entry level overview to green synthetic methods, including waste reduction processes explained through use of synthetic reactions commonly performed in industrial settings; amide bond formation, alkene reduction and deoxychlorination. Solvent use and alternatives to toxic solvents; mechanochemistry, ionic liquids, water, supercritical carbon dioxide (scCO2) and biorenewable solvents – applications to industrial settings. Solvent selection guides. Society reliant chemicals – commodity and fine chemicals. Reliance on their production from fossil fuels and possible alternative sources such as biorenewable lignocellulosic biomass Use of biorenewable platform chemicals in chemical synthesis, with case studies. Lignin and its potential.
Block IV	**Future Trends in Green Chemistry** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solvent less reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	**Reference Books:** 1. Manahan S.E. (2005) Environmental Chemistry, CRC Press 2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole 3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New Ryan, M.A. Introduction to Green Chemistry, Tinnes and; (Ed), American Chemical Society, Washington DC (2002). Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).

IV-Semester

Course Code **DBSPCO401T24**	**Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand the general characteristics of the d block elements and the bonding in coordination compounds.	
CO 2	Explain the chemistry of organ metallic compounds, metal carbonyls and metal clusters.	
CO 3	Apply the concept of rate laws e.g., order, molecularity, half-life and their determination on chemical reaction.	
CO 4	Classify ideal and real gases on the basis of gas law and critical phenomenon.	
CO 5	Evaluate the properties of liquids especially surface tension and viscosity.	
CO 6	Set up symmetry elements, crystal structure specially NaCl, KCl and CsCl.	
Course Content		
Block I	**Transition Elements and Lanthanoids and Actinoids** Transition Elements (3d series): General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).	
Block II	**Coordination Chemistry** Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT.IUPAC system of nomenclature. **Crystal Field Theory** Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical Series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.	

Block III	**State of Matter** Kinetic Theory of Gases: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behavior, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals Equation. Andrews isotherms of CO_2 Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only). Liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only). Solids: Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only).Defects in crystals. Glasses and liquid crystals.
Block IV	**Chemical Kinetics** Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants).Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF

Text books	1. Lee, J. D. A new Concise Inorganic Chemistry, Pearson Education. Page 20 of 96 B.Sc. Physical Science 2. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkin's Inorganic Chemistry, Oxford. 3. Miessler, G. L.; Tarr, D.A. (2014), Inorganic Chemistry, Pearson. 4. Castellan, G. W.(2004),Physical Chemistry, Narosa. 5. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.1, 6th Edition, McGraw Hill Education. 6. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.5, 3rd Edition, McGraw Hill Education. 7. B.R. Puri, L.R. Sharma, M.S. Pathania, (2017),Principles of Physical Chemistry, Vishal Publishing Co. *Barrow,* G.M. Physical Chemistry Tata McGraw-Hill (2007). 8. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998). 9. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985). 10. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley

Course Code **DBSPCO402T24**	**Electricity and Magnetism**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Explain various phenomena like Ferromagnetism, ant ferromagnetism etc.	
CO 2	Understand the relation in between Electromagnetic theory.	
CO 3	Demonstrate a working understanding of capacitors.	
CO 4	Verify of various circuit laws, network theorems elaborated above, using simple electric circuits.	
CO 5	Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.	
CO 6	Analyze propagation of wave in different media.	
Course Content		
Block I	**Vector Analysis:** Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stroke's theorem of vectors (statement only).	
Block II	**Electrostatics & Magnetostatics** Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarization, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. Magnetism: Magneto statics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law	
Block III	**Electromagnetic Induction** Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials. Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field. Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field.	

Block IV	**EM Wave Propagation in Unbounded Media** 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.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education. 2. Electricity and Magnetism, J.H. Fewkes & J. Yarwood, Vol. I, 1991, Oxford Univ. Press. 3. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House. 4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. 5. D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

Course Code **DBSPCO403T24**	**Abstract Algebra**	**C-4**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define the fundamental concepts including groups, subgroups, normal subgroups, homomorphism and isomorphism.	
CO 2	Understand and prove fundament results and solve algebraic problem using appropriate techniques.	
CO 3	Apply algebraic ways of thinking.	
CO 4	Demonstrate knowledge and understanding of rings, fields and their properties.	
CO 5	Analyze the ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions.	
CO 6	Demonstrate insight into abstract algebra with focus on axiomatic theories.	
Course Content		
Block I	Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo and the group U(n) of units under multiplication modulon. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.	
Block II	Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction	
Block III	Subgroups, cyclic sub groups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cossets, Index of subgroup, Lagrange's theorem, order of an element,Normalsubgroups:theirdefinition,examples,andcharacterizations, Quotient groups	
Block IV	Definition and examples of rings, examples of commutative and non- commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002. 2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011. 3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999. 4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995. 5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.	

Course Code **DBSPCO401P24**	**Transition Metal & Coordination chemistry, States of Matter & Chemical Kinetics lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the process Semi-micro qualitative analysis of mixtures of ionic species.	
CO 2	Perform Estimate the amount of nickel, (i) Mg^{2+} or (ii) Zn^{2+} and total hardness.	
CO 3	Calibrate the viscometer and Surface tension.	
CO 4	Determination of the relative and absolute viscosity and Chemical Kinetics	
CO 5	Develop method to determination of rate of reaction.	
Exercises		
Exercise 1.	Section A: Inorganic Chemistry	
Exercise 2.	Semi-micro qualitative analysis (using H_2S or other methods) of mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of the following:	
Exercise 3.	Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+},Ca^{2+}, K^+	
Exercise 4.	Anions : CO_3^{2-} , S^{2-}, SO^{2-}, $S_2O_3^{2-}$, NO^{3-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-},BO_3^{3-}, $C_2O_4^{2-}$, F^-	
Exercise 5.	Estimate the amount of nickel present in a given solution as bis (dimethylglyoximato) nickel (II) or aluminium as oximate in a given solution gravimetrically.	
Exercise 6.	Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.	
Exercise 7.	Estimation of total hardness of a given sample of water by complexometric titration.	
Exercise 8.	Section B: Physical Chemistry	
Exercise 9.	Surface tension measurement (use of organic solvents excluded).	
Exercise 10.	Determination of the surface tension of a liquid or a dilute solution using an stalagmometer.	
Exercise 11.	Study of the variation of surface tension of a detergent solution with concentration.	
Exercise 12.	Viscosity measurement (use of organic solvents excluded).	
Exercise 13.	Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.	
Exercise 14.	Study of the variation of viscosity of an aqueous solution with concentration of solute.	
Exercise 15.	Chemical Kinetics: Study the kinetics of the following reactions. Initial rate method: Iodide-persulphate reaction	
Exercise 16.	Acid hydrolysis of methyl acetate with hydrochloric acid.	
Exercise 17.	Saponification of ethyl acetate.	
Exercise 18.	Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009. 3. Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).	

Course Code **DBSPCO402P24**	**Electricity and Magnetism Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the protocol for measuring Resistance voltage and current.	
CO 2	Assemble the De sauty bridge and Rayleigh method for determination of inductance and capacitances.	
CO 3	Demonstrate LCR circuit and determine its (a) Anti-resonant frequency and Quality factor Q	
CO 4	Formulate the verification the Thevenin and Norton theorem.	
CO 5	Develop various parts of electrical instruments and various types of bridges.	
Exercises		
Exercise 1.	To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.	
Exercise 2.	Ballistic Galvanometer (a) Measurement of charge and current sensitivity, (b) Measurement of CDR (c) Determine a high resistance by Leakage Method	
Exercise 3.	To determine Self Inductance of a Coil by Rayleigh's Method.	
Exercise 4.	To compare capacitances using De' Sauty bridge.	
Exercise 5.	Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).	
Exercise 6.	To study the Characteristics of a Series RC Circuit.	
Exercise 7.	To study the series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor	
Exercise 8.	To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and Quality factor Q	
Exercise 9.	To determine a Low Resistance by Carey Foster's Bridge.	
Exercise 10.	To verify the Thevenin and Norton theorem.	
Exercise 11.	To verify the superposition and maximum power transfer theorem.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House. 2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi. 3. Engineering Practical Physics, S. Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd. 4. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers	

Course Code **DBSPDS401T24**	**Analytical Methods in Chemistry**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Discuss the concept of accuracy and precision in experimental determination of data.	
CO 2	Understand methods of analysis for different samples independently.	
CO 3	Apply different Test on contaminated water samples.	
CO 4	Analyze principle of instrument like Flame Photometer, UV-vis spectrophotometer and chromatography.	
CO 5	Apply knowledge of geometrical isomers and keto-enol tautomers to analysis.	
CO 6	Determine composition of soil and Estimate macronutrients using Flame photometry.	
Course Content		
Block I	**Qualitative and quantitative aspects of analysis** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	
Block II	**Optical methods of analysis** Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution. Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.	
Block III	**Thermal methods of analysis** Thermal methods of analysis: Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values	

Block IV	**Separation techniques** Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Willard, H.H.(1988),Instrumental Methods of Analysis, 7th Edition, Wardsworth Publishing Company. 2. Christian, G.D. (2004), Analytical Chemistry, 6th Edition, John Wiley & Sons, New York. 3. Harris, D. C.(2007),Quantitative Chemical Analysis,6th Edition, Freeman. 4. Khopkar, S.M. (2008), Basic Concepts of Analytical Chemistry, New Age International Publisher. 5. Skoog, D.A.; Holler F.J. Nieman, T.A. (2005), Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 6. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001. 7. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009. 8. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.

Course Code **DBSPDS402T24**	**Atomic and Molecular Physics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Estimate the energy spectrum of fine and hyperfine interactions, Zeeman effect and Stark's effect.	
CO 2	Understand Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.	
CO 3	Evaluate transition rate in one-electron atom.	
CO 4	Apply the concept of Emission and Absorption of Electromagnetic Radiation by Atoms.	
CO 5	Calculate the wave functions and energies for the two and many electron atoms.	
CO 6	Develop skills in molecular spectra, particularly in diatomic molecules and lasers.	
Course Content		
Block I	**The Concept of the Atom**: Size of Atoms, Electric Structure of Atoms, One electron atom, Electron spin and Vector model, Pauli's principle, Spin orbit interaction, Hydrogen fine structure, He atom and its spectrum, Multielectron atoms.	
Block II	**Atoms in Electric and 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.	
Block III	**Emission and Absorption of Electromagnetic Radiation by Atoms** Electron Spin, Spectra of Alkali elements, Spectra of Alkaline earth elements, Hyperfine structure of spectral lines, Line broadening mechanism (general idea), Complete Description of the Hydrogen Atom. Emission and Absorption of Electromagnetic Radiation by Atoms: Transition Probabilities, Selection Rules, Diatomic Molecules, Molecular Binding, Rotation and Vibration of Diatomic Molecules, Spectra of Diatomic Molecules.	
Block IV	**Many electron atom & Laser** Many electron atoms- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Lasers: Physical Principles, Optical Resonators, Single Mode Lasers, Nonlinear Optics of laser, Generation of Short Laser Pulses.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Physics of atoms and molecules by B. Bransden, 2003, Prentice Hall. 2. Atomic, Molecular, and Optical Physics Handbook by Gordon W. F. Drake, 1996, Springer. 3. The Fundamentals of Atomic and Molecular Physics by Robert L. Brooks, 2013, Springer New York. 4. Atomic and Molecular Physics by Kumar Raj, 2013, Campus Books International	

Course Code **DBSPDS403T24**	**Mathematical Methods**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define Laplace transformation of derivatives.	
CO 2	Illustrate numerical methods to solve integral transform.	
CO 3	Formulate and Solve ordinary differential equation.	
CO 4	Evaluate Fourier integral.	
CO 5	Implement the formulation of Euler equation.	
CO 6	Construct shortest distance between two non-intersecting curves.	
Course Content		
Block I	Laplace Transformation, Laplace Transforms of derivatives and integrals, shifting theorems, Dirac's delta function, differentiation and integration of transforms, convolution theorem.	
Block II	Integral equations, Application of Laplace transform in solution of ordinary differential equations. Fourier series expansion, Half-range expansions, Fourier integrals	
Block III	Functionals, Deduction of Euler's equations for functionals of first order and higher order for fixed boundaries	
Block IV	Shortest distance between two nonintersecting curves. Isoperimetric problems. Jacobi and Legendre conditions (applications only).	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Son Inc., New York, 1999. 2. N. Kumar, An Elementary Course on Variational Problems in Calculus, Narosa Publications, New Delhi. 3. A. S. Gupta, Text Book on Calculus of Variation, Prentice-Hall of India, New Delhi. 4. S. G. Deo, V Lakshmikanthna and V. Raghavendra, Text Book of Ordinary Differential Equations, Tata McGraw-Hill. 5. F. B. Hilderbrand, Advanced Calculus for Applications, PHI, New Delhi, 1997. 6. B. Rai, D. P. Choudhary, H.I. Freedman, Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.	

Course Code DBSPDS401P24	Analytical Methods in Chemistry lab	C-1
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the principle of spectrophotometer	
CO 2	Perform chromatographic Methods to analysis.	
CO 3	Combine the different extraction methods.	
CO 4	Demonstrate the analytical techniques procedure for identification and estimation.	
CO 5	Develop Analysis of water sample.	
Exercises		
Exercise 1.	I. Separation Techniques Chromatography: (a) Separation of mixtures (i) Paper chromatographic separation of Fe3+, Al3+, and Cr3+. (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values. (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values. (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC	
Exercise 2.	Solvent Extractions: (i) To separate a mixture of Ni2+ & Fe2+ by complexation with DMG and extracting the Ni2+- DMG complex in chloroform, and determine its concentration by spectrophotometry. (ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.	
Exercise 3.	Spectrophotometry 1. Determination of pKa values of indicator using spectrophotometry. 2 Structural characterization of compounds by infrared spectroscopy.	
Exercise 4.	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.	
Exercise 5.	Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.	
Exercise 6.	Analysis of soil: (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium, phosphate, nitrate	
Exercise 7.	Ion exchange: (i) Determination of exchange capacity of cation exchange resins and anion exchange resins. (ii) Separation of metal ions from their binary mixture. (iii) Separation of amino acids from organic acids by ion exchange chromatography.	
Exercise 8.	Determination of dissolved oxygen in water.	
Exercise 9.	Determination of chemical oxygen demand (COD).	
Exercise 10.	Determination of Biological oxygen demand (BOD).	

Exercise 11.	Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989. 2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988. 3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004. 4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001. 5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009. 6. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed. 7. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979. 8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

Course Code **DBSPDS402P24**	**Atomic and Molecular Physics lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Measure the Planks constant using solar cell.	
CO 2	Execute experimental results in terms of quantum mechanics.	
CO 3	Electron spin resonance- determine magnetic field as a function of the resonance frequency.	
CO 4	Articulate Electron spin resonance- determine magnetic field as a function of the resonance frequency.	
CO 5	Develop the concept of Zeeman effect: with external magnetic field; Hyperfine splitting.	
Exercises		
Exercise 1.	Study of Zeeman effect: with external magnetic field; Hyperfine splitting.	
Exercise 2.	Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.	
Exercise 3.	To study the quantum tunneling effect with solid state device.	
Exercise 4.	Determination of Plank's constant using Solar cell.	
Exercise 5.	To determine the Stefan's constant (B-B method).	
Exercise 6.	Determination of Plank constant by photo cell (retarding potential method using optical filters).	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House. 2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi. 3. Engineering Practical Physics, S. Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.	

Course Code **DBSPDS403P24**	**Mathematical Methods Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Perform abstract algebra with focus on axiomatic theories.	
CO 2	Follow and apply algebraic ways of thinking.	
CO 3	Demonstrate knowledge and understanding of fundamental concepts including groups, subgroups, normal subgroups, homomorphism and isomorphism.	
CO 4	Demonstrate knowledge and understanding of rings, fields and their properties.	
CO 5	Understand and prove fundament results and solve algebraic problem using appropriate techniques.	
Exercises		
Exercise 1.	Introduction to Matlab	
Exercise 2.	Random walks and programming in Matlab (Mathematics: vectors, matrices, matrix addition)	
Exercise 3.	Random walks and programming in Matlab (Multiplication, linear maps, basic probability)	
Exercise 4.	Developing a mathematical model	
Exercise 5.	Developing a mathematical model	
Exercise 6.	Developing a mathematical model	
Exercise 7.	Developing various types of mathematical model. 2D model, SIR, SIER models	
Exercise 8.	Developing various types of mathematical model. 2D model, SIR, SIER models	
Exercise 9.	Developing various types of mathematical model. 2D model, SIR, SIER models	
Exercise 10.	Developing various types of mathematical model. 2D model, SIR, SIER models	
Exercise 11.	Developing various types of mathematical model. 2D model, SIR, SIER models	
Exercise 12.	Developing various types of mathematical model. 2D model, SIR, SIER models	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998. 2. P.R. Halmos, *Naive Set Theory*, Springer, 1974. 3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950	

Course Code **DBSPAE401T24**	**Intellectual Property Rights**	**C-2**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Explain the basics of intellectual property rights with special reference to Indian laws and its practices.	
CO 2	Summarize the different forms of intellectual property protection in terms of their key differences and similarities.	
CO 3	Determine the overview of the statutory, procedural and case law underlining these processes and their interplay with litigation.	
CO 4	Encourage and protect innovation in the form of intellectual property rights.	
CO 5	Assess the Information Technology Related Intellectual Property Rights.	
CO 6	Develop the Biotechnology and Intellectual Property Rights.	
Course Content		
Block I	Introduction to intellectual property right (IPR) Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO). Patents Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement Copyrights Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.	
Block II	Trademarks Objectives, Types, Rights, Protection of goodwill, Infringemnt, Pas sing off, Defences, Domain name. Geographical Indications Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position. Protection of Traditional Knowledge Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generisregime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library	
Block III	Industrial Designs Objectives, Rights, Assignments, Infringements, Defences of Design Infringement Protection of Plant Varieties Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights off armers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers Rights Act, 2001.	
Block IV	Information Technology Related Intellectual Property Rights Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection, Biotechnology and Intellectual Property Rights. Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. N.K. Acharya: *Textbook on intellectual property rights,* Asia Law House (2001). 2. Manjula Guru & M.B. Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003). 3. P. Ganguli, *Intellectual Property Rights: Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001). 4. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000). 5. Jayashree Watal ,*Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.

Course Code **DBSPVA401T24**	**Quantities Aptitude**	**C-2**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Describe formation of Equation related to number and ages problem.	
CO 2	Explain Time and work, Profit and loss related problem.	
CO 3	Apply the Concept of a Number series, and calendar related problem.	
CO 4	Characterizations of various types of probability.	
CO 5	Know about Bays theorem and its application.	
CO 6	Develop the Structure of pie chart, bar graph etc.	
Course Content		
Block I	**Arithmetic Ability** Percentage, Problems on Numbers and Ages, Ratio, Average, Fraction, Square and Cube. Time & Work, Time & Distance, Profit & Loss , Simple and Compound Interest	
Block II	**Series Completion** Number series, Alphabet series and Alpha-Numeric series, Calendar, Syllogism, Cube, Mirror image, Blood relation.	
Block III	**Probability-** Sample space , PMF, PDF, Conditional probability, Bays theorem	
Block IV	**Data Interpretation** Tabulation, Pie chart, Line Graph, Ogive	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Quantitative Aptitude for Competitive Examinations (Edition 2022)by Dr. R S Agarwal; Publisher: S. Chand 2. Arithmetic by Dr. R S. Agarwal, Publisher: S. Chand Bureau of Indian Standards, New Delhi, 1999	

Exit option with Diploma in Computational Mathematics/Analytical Chemistry

* Credits of Open Elective courses can be obtained from MOOC and SWAYAM courses

V-Semester

Course Code **DBSPCO501T24**	**Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	To get a deep insight into the various spectroscopic methods used for the characterization of organic compounds.	
CO 2	Enable the students to elucidate the structure of compounds by analyzing the spectral data.	
CO 3	To know the basics principle of different techniques employed in molecular spectroscopy.	
CO 4	To study the origin, instrumentation and important applications of Microwave, IR, Raman, UV techniques.	
CO 5	To understand the functions and applications of bioorganic compounds	
CO 6	To have a basic idea about nuclear Chemistry and its applications	
Course Content		
Block I	**Chemistry of 3d metals** Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$. Organometallic Compounds Definition and Classification with appropriate examples based on nature of metal carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behavior of carbon monoxide. Synergic effects (VB approach), (MO diagram of CO can be referred to for synergic effect to IR frequencies).	
Block II	**Bio-Inorganic Chemistry** A brief introduction to bioinorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+, Mg^{2+} , Fe^{2+}/Fe^{3+}ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).	
Block III	**Polynuclear and Heterocyclic compounds:** Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene , Furan, Pyrrole, Thiophene, and Pyridine. Active methylene compounds: Preparation: Claisen ester condensation. Keto-enol Tautomerism. Reactions: Synthetic uses of ethyl acetoacetate (preparation of non-heteromolecules having up to 6 carbon).	

Block IV	**Application of Spectroscopy to Simple Organic Molecules** Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λmax & ε max, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α, β– unsaturated compounds. Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. James E. Huheey, Ellen Keiter& Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication. 2. G.L. Miessler & Donald A. Tarr: Inorganic Chemistry, Pearson Publication. 3. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S. 4. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley & Sons. 5. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S. 6. John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds, Prentice Hall. 7. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons. 8. R.T. Morrison & R.N. Boyd: Organic Chemistry, Prentice Hall. 9. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.

Course Code **DBSPCO502T24**	**Solid State Physics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define interatomic forces and bonds have a basic knowledge of crystal systems and spatial symmetries.	
CO 2	Understand crystalline materials are studied using diffraction, including concepts like form factor, structure factor, and scattering amplitude.	
CO 3	Analyze thermal and electrical properties in the free-electron model.	
CO 4	Apply the fundamental principles of semiconductors, including p-n junctions, and be able to estimate the charge carrier mobility and density.	
CO 5	Evaluate comprehend for what the Fermi surface is and how it can be measured.	
CO 6	Develop the concept of crystal structure and properties.	
Course Content		
Block I	**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.	
Block II	**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 Pettit's Law, Einstein and Debye theories of specific heat of solids. T law	
Block III	**Magnetic Properties of Matter:** Día-, Para-, Ferric- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Para magnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. 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.	
Block IV	**Elementary band theory:** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient. Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd. 2. Elements of Solid-State Physics, J.P. Srivastava, 2ndEd., 2006, Prentice-Hall of India 3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill 4. Solid State Physics, Rita John, 2014, McGraw Hill

Course Code **DBSPCO503T24**	**Probability and Statistics**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Appreciate the importance of probability and statistics in computing and research.	
CO 2	Develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries.	
CO 3	Apply appropriate statistical methods in the analysis of simple datasets.	
CO 4	Analyze function of two random variables.	
CO 5	Can Conclude the Chebyshev's inequality, statement and interpretation.	
CO 6	Develop the concept of classification of states.	
Course Content		
Block I	Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function	
Block II	Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions	
Block III	Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables	
Block IV	Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007. 2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia,2006. 3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007. 4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint2007 5. D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998	

Course Code **DBSPCO501P24**	**Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the procedure of chromatography techniques.	
CO 2	Correlate various parameters of theory with practical applications.	
CO 3	Perform Gravimetric analysis	
CO 4	Demonstrate of new inorganic complexes.	
CO 5	Develop the identification of organic compounds.	
Exercises		
Exercise 1.	Separation of mixtures by paper chromatography: Measure the R_f value in each case. (Combination of two ions to be given) Paper chromatographic separation of $Fe^{3+,}$ $A1^{3+}$ and Cr^{3+} or Paper chromatographic separation of Ni^{2+}, $Co^{2+,}$ Mn^{2+} and Zn^{2+}	
Exercise 2.	Preparation of any two of the following complexes and measurement of their conductivity: (i) tetraamminecarbonatocobalt (III) nitrate (ii) tetraamminecopper (II) sulphate (iii) potassium trioxalatoferrate (III) trihydrate	
Exercise 3.	Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and LiCl3.	
Exercise 4.	Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn. 2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn. 3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996. 4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.	

Course Code **DBSPCO502P24**	**Solid State Physics Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the path for measurement of Magnetic susceptibility of solids.	
CO 2	Perform determination of Coupling Coefficient of a Piezoelectric crystal.	
CO 3	Demonstrate PE Hysteresis loop of a Ferroelectric Crystal.	
CO 4	Draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.	
CO 5	Measure the resistivity of a semiconductor (Ge) with temperature by four-probe method.	
Exercises		
Exercise 1.	Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)	
Exercise 2.	To measure the Magnetic susceptibility of Solids	
Exercise 3.	To determine the Coupling Coefficient of a Piezoelectric crystal	
Exercise 4.	To measure the Dielectric Constant of a dielectric Materials with frequency	
Exercise 5.	To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)	
Exercise 6.	To determine the refractive index of a dielectric layer using SPR	
Exercise 7.	To study the PE Hysteresis loop of a Ferroelectric Crystal.	
Exercise 8.	To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.	
Exercise 9.	To measure the resistivity of a semiconductor (Ge) with temperature by four-probe, method (room temperature to 150^{o} C) and to determine its band gap.	
Exercise 10.	To determine the Hall coefficient of a semiconductor sample.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House. 2. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers 3. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal 4. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.	

Course Code **DBSPDS501T24**	**Inorganic Materials of Industrial Importance**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define basics principle of different techniques employed in Silicate Industries.	
CO 2	Understand Different types of fertilizers and Manufacture.	
CO 3	Apply the applications and Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings.	
CO 4	Analyze the Working of batteries, Manufacture of Steel.	
CO 5	Evaluate the basic idea about Origin of explosive properties in organic compounds.	
CO 6	Develop the concept of catalysis and chemical explosives.	
Course Content		
Block I	**Silicate Industries:** Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fiber. Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.	
Block II	**Fertilizer and Surface Coating** Fertilizers: Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. Surface Coatings: Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.	
Block III	**Batteries and Alloys** Batteries: Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell. Alloys: Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels	

Block IV	**Catalysis and Chemical explosive** Catalysis: General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Chemical explosives: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK. 2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi. 45 3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi. 4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi. 6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi. 7. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meeru

Course Code DBSPDS502T24	Nuclear Physics	C-3
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand about the Concept and principle of Nuclear and particle physics.	
CO 2	Apply knowledge of core concepts in physics to more advanced topics in nuclear and particle physics.	
CO 3	Formulate solutions to problems in nuclear and particle physics involving new concepts with limited guidance.	
CO 4	Demonstrate knowledge of the frontiers of the discipline, for example, through cases where current theories fail to explain a set of experimental data.	
CO 5	Locate and make use of detailed information on current topics in physics in the primary research literature.	
CO 6	Develop current thinking in nuclear and particle physics in a variety of written and oral forms, both alone and in collaboration with others.	
Course Content		
Block I	**General Properties of Nuclei** 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.	
Block II	**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.	
Block III	**Nuclear Reactions & Nuclear Detectors** 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). 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.	
Block IV	**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.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Text books	1. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998). 2. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004). 3. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press 4. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons 5. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi 6. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004). 7. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000). 8. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic 50 Press, Elsevier, 2007). 9. Theoretical Nuclear Physics, J.M. Blatt &V.F. Weisskopf (Dover PubInc., 1991) physics Pub. 10. Basic ideas and concepts in Nuclear Physics, K. Heyde, 3rd Edn., Institute of P Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).

Course Code **DBSPDS503T24**	**Operating System LINUX**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Explain the fundamental components of a computer operating system	
CO 2	Understand the fundamental components of a computer operating system	
CO 3	Apply the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.	
CO 4	Describe and extrapolate the interactions among the various components of computing systems.	
CO 5	Design and construct the following OS components: System calls, Schedulers, Memory management systems, Virtual Memory and Paging systems.	
CO 6	Illustrate, construct, compose and design solutions via C/C++ programs, and through NACHOS.	
Course Content		
Block I	Linux – The Operating System: Linux history, Linux features, Linux distributions, Linux's relationship to Unix	
Block II	Overview of Linux architecture, Installation, Startup scripts, system processes (an overview), Linux Security, The Ext2 and Ext3 File systems: General Characteristics of, The Ext3 File system, file permissions	
Block III	User Management: Types of users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools.	
Block IV	Resource Management in Linux: file and directory management, system calls for files Process Management, Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls for processes, Memory Management, library and system calls for memory	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Arnold Robbins, *Linux Programming by Examples. The Fundamentals*, 2nd Ed., Pearson Education, 2008. 2. Cox K, *Red Hat Linux Administrator's Guide*, PHI, 2009. 3. R. Stevens, *UNIX Network Programming*, 3rd Ed., PHI, 2008. 4. Sumitabha Das, *Unix Concepts and Applications*, 4th Ed., TMH, 2009. 5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, *Linux in a Nutshell*, 6th Ed., O'Reilly Media, 2009. 6. Neil Matthew, Richard Stones, Alan Cox, *Beginning* 7. *Linux Programming*, 3rd Ed., 2004.	

Course Code **DBSPDS501P24**	**Inorganic Materials of Industrial Importance lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the principles of basic science concepts in understanding, analysis and preparation of inorganic materials.	
CO 2	Calibrate the amount of metals in fertilizers.	
CO 3	Demonstrate the protocol to determine calcium in calcium ammonium nitrate fertilizer.	
CO 4	Perform analysis of metals in alloys	
CO 5	Develop ideas and techniques required in emergent area of industrial chemical analysis	
Exercises		
Exercise 1.	Determination of free acidity in ammonium sulphate fertilizer.	
Exercise 2.	Estimation of calcium in calcium ammonium nitrate fertilizer.	
Exercise 3.	Estimation of phosphoric acid in superphosphate fertilizer.	
Exercise 4.	Electro less metallic coatings on ceramic and plastic material.	
Exercise 5.	Determination of composition of dolomite (by complex metric titration).	
Exercise 6.	Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.	
Exercise 7.	Analysis of Cement.	
Exercise 8.	Preparation of pigment (zinc oxide).	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK. 2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi. 3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi. 4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi. 5. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi. 6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi. 7. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).	

Course Code **DBSPDS502P24**	**Nuclear Physics Lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the concept of radioactivity, properties of radioactive element, energy of gamma rays.	
CO 2	Design spectrum of beta particles using gamma ray spectroscopy.	
CO 3	Calibrate a scintillation counter and determine energy of gamma rays from an unknown source	
CO 4	Demonstrate the Bremsstrahlung effect using Scintillation spectroscopy	
CO 5	Calculate the end point of beta particle using beta ray spectrometer	
Exercises		
Exercise 1.	To determine the operating voltage and dead time of GM counter using Cs137radioisotops.	
Exercise 2.	To determine the absorption coefficient of Aluminum and lead for Beta particles using Cs137 radioisotopes and GM counter.	
Exercise 3.	To study the statistical nature of radioactive decay using GM counter and Cs137 radioisotopes.	
Exercise 4.	To study spectrum of beta particles using gamma ray spectroscopy.	
Exercise 5.	To calibrate a scintillation counter and determine energy of gamma rays from an unknown source.	
Exercise 6.	To study the alpha particle using spark chamber.	
Exercise 7.	To study the Bremsstrahlung effect using Scintillation spectroscopy.	
Exercise 8.	To study Crompton scattering of gamma-rays and verify the energy shift formula.	
Exercise 9.	To determine the end point of beta particle using beta ray spectrometer.	
Exercise 10.	To determine the half-life a radio isotope using GM counter.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House. 2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers 3. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal 4. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.	

Course Code DBSPDS503P24	Operating System LINUX Lab	C-1
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the fundamental concepts of open-source operating system Linux	
CO 2	Draw the basic set of commands and editors in Linux operating system.	
CO 3	Demonstrate shell programming in Linux operating system	
CO 4	Perform shell script to perform integer arithmetic operations	
CO 5	Design a shell program to find out reverse string of the given string and check the given string is palindrome or not	
Exercises		
Exercise 1.	Linux installation ubuntu. Basic commands of LINUX VI editor commands	
Exercise 2.	Shell Scripting Programming: using expr command for mathematics operation. Define variable: user and predefine. Use condition: if else Loops for, while for find sum 1 to 10 digit.	
Exercise 3.	Write shell script to perform integer arithmetic operations	
Exercise 4.	Write a shell script to perform floating point arithmetic operations using command line arguments	
Exercise 5.	Write a shell script to check the given file is writable or not	
Exercise 6.	Write a shell program to find out reverse string of the given string and check the given string is palindrome or not.	
Exercise 7.	Write a shell program to find out reverse string of the given string and check the given string is palindrome or not.	
Exercise 8.	Write a shell program to find out reverse string of the given string and check the given string is palindrome or not.	
Exercise 9.	Write a shell script that computes the gross salary of a employee according to the following 1) if basic salary is <1500 then HRA 10% of the basic and DA =90% of the basi 2) if basic salary is >=1500 then HRA 500 and DA =98% of the basic The basic salary is entered interactively through the key board.	
Exercise 10.	Write a shell script that accepts a file name, starting and ending line numbers as arguments and displays all the lines between the given line numbers	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	Sumitabha Das, *Unix Concepts and Applications*, 4th Ed., TMH, 2009.	

Course Code DBSPVA501T24	Web Designing	C-2
Course Outcomes	After completion of this course, a student will be:	
CO 1	Describe Electronic publishing using list; table. Working with HTML element and attribute.	
CO 2	Discuss Web-Page Pseudo element and style sheet.	

CO 3	Show the CSS Working with block element and tables.
CO 4	Classify page layout with advanced CSS properties
CO 5	Appraise the HTML page meet the requirement and properly positioned.
CO 6	Develop a Website using HTML & CSS.
Course Content	
Block I	Electronic publishing - lists and their types - nested lists - table handling- Working with Hyperlinks, Images and Multimedia- Frames: Frameset definition – frame definition – nested framesets.
Block II	Pseudo-elements – defining Styles – elements of styles – linking a style sheet to a HTML document – inline styles – External style sheets – internal Style sheets – Multiple Styles – Web page Designing.
Block III	Concept of CSS -Creating Style Sheet - CSS Properties - CSS Styling(Background-Text Format Controlling Fonts) - Working with block elements and objects -Working with Lists and Tables. CSS Advanced(Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector) -CSS Color -Creating page Layout and Site Designs.
Block IV	Forms and form elements- Creating the Web Site -Saving the site -Working on the web site - Creating web site structure -Creating Titles for web pages -Themes—Div- SPAN-table-frames
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. Raj kamal ,internet and web technologies , Tata Mcgraw Hill (2007) 2. Joel sklar , principles of web design ,Thomson (2007)

VI –Semester

Course Code **DBSPCO601T24**	**Quantum Chemistry, Spectroscopy & Photochemistry**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define the classical quantum chemistry concepts.	
CO 2	Explain the concepts of the fundamentals of quantum mechanics and its applications in the study of structure of atoms, bonding in molecules and molecular spectroscopy.	
CO 3	Apply the concept of valence bond and molecular orbital theory.	
CO 4	To impart a thorough knowledge of the fundamentals of microwave, infra-red, Raman, electronic and magnetic resonance spectroscopy, mass spectrometry and photochemistry	
CO 5	Justify the energy levels of diatomic molecules.	
CO 6	Develop the knowledge of different spectroscopy techniques.	
Course Content		
Block I	**Quantum Chemistry** Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical Harmonics. Discussion of solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, and quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom	
Block II	**Chemical bonding** Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localized and non-localized molecular orbitals treatment of triatomic (BeH2, H2O) molecules. Qualitative MO theory and its application to AH2 type molecules	

Block III	**Spectroscopy** Molecular Spectroscopy: Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. Rotational spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion. Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules. Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.
Block IV	**Photochemistry** Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc
Text books	1. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy4th Ed. Tata McGraw-Hill: New Delhi (2006). 2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001). 3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004). 4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005). 5. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).

Course Code **DBSPCO602T24**	**Quantum Mechanics and Applications**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Discuss and interpret experiments that reveal the wave properties of matter	
CO 2	Understand how this motivates replacing classical mechanics with a wave equation.	
CO 3	Understand the central concepts and principles in quantum mechanics	
CO 4	Define the Schrödinger equation, the wave function and its statistical interpretation	
CO 5	Understand the uncertainty principle, stationary and non-stationary states, time evolution of solutions	
CO 6	Able to define the relation between quantum mechanics and linear algebra.	
Course Content		
Block I	**Basics of quantum Mechanics** Planck's quantum, Planck's constant and light as a collection of photons; Photoelectric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra. Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	
Block II	**Schrodinger Equation** Two slit interference experiment with photons, atoms & 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 wave function, probabilities and normalization; Probability and probability current densities in one dimension.	
Block III	**Applications of Schrodinger equation** One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as an example; Quantum mechanical scattering and Tunneling in one dimension - across a step potential and across a rectangular potential barrier. Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in nucleus as a consequence of the uncertainty principle.	

Block IV	**Nuclear Forces & Radioactivity** Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy. Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission. 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.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill 2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn, 2002, Wiley. 3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill. 4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India. 5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning. 6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer 7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Course Code **DBSPCO603T24**	**Linear Programming Problem**	**C-4**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand the linear optimization theory and its applications.	
CO 2	Identify the appropriate methods for the efficient computation of optimal solutions of a problem and a set of linear constraints	
CO 3	Ready to model a problem as a linear programming problem and to apply the appropriate method in order to find an optimal solution	
CO 4	Apply Methods of finding initial basic feasible solutions; North West corner rule. Least cost method; Vogel's Approximation method.	
CO 5	Conclude the Duality Theory of Linear Programming	
CO 6	Develop the concept of Mathematical formulation and Hungarian method of solving.	
Course Content		
Block I	Introduction to Linear Programming, The Linear Programming Problem: Standard, Canonical and matrix forms, Graphical solution. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution.	
Block II	Methods of Solving Linear Programming Problem Simplex, Method: Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness; Simplex Algorithm and its Tableau Format; Artificial variables, Two-phase method, Big-M method.	
Block III	Duality Theory of Linear Programming: Motivation and Formulation of Dual problem; Primal-Dual relationships; Fundamental Theorem of Duality; Complimentary Slackness.	
Block IV	Applications: Transportation Problem: Definition and formulation; Methods of finding initial basic feasible solutions; North West corner rule. Least cost method; Vogel's Approximation method; Algorithm for solving Transportation Problem. Assignment Problem: Mathematical formulation and Hungarian method of solving.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004. 2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 8th Ed., Tata McGraw Hill, Singapore, 2004. 3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.	

Course Code **DBSPCO601P24**	**Quantum Chemistry, Spectroscopy & Photochemistry lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the fundamental principles of different instruments.	
CO 2	Perform work on UV Spectrometer and calorimeter.	
CO 3	Demonstrate analysis on colourimeter.	
CO 4	Perform UV analysis.	
CO 5	Develop separation of component by UV and calorimeter.	
Exercises		
Exercise 1.	UV/Visible spectroscopy Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol-1, cm-1, eV).	
Exercise 2.	Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.	
Exercise 3.	Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.	
Exercise 4.	Colourimetry I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration	
Exercise 5.	Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.	
Exercise 6.	Study the kinetics of iodination of propanone in acidic medium.	
Exercise 7.	Determine the amount of iron present in a sample using 1, 10-phenathroline.	
Exercise 8.	Determine the dissociation constant of an indicator (phenolphthalein).	
Exercise 9.	Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.	
Exercise 10.	Analyse the given vibration-rotation spectrum of HCl (g)	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009. 2. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). 3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003). 4. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).	

Course Code DBSPCO602P24	Quantum Mechanics and Applications Lab	C-1
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the procedure of Measurement of Planck's constant using black body radiation and photo-detector	
CO 2	Perform determination the wavelength of H-alpha emission line of Hydrogen atom	
CO 3	Calibrate work function of material of filament of directly heated vacuum diode	
CO 4	Setup the Millikan oil drop apparatus and determine the charge of an electron	
CO 5	Design the Millikan oil drop apparatus and determine the charge of an electron	
Exercises		
Exercise 1.	Measurement of Planck's constant using black body radiation and photo-detector	
Exercise 2.	Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light	
Exercise 3.	To determine work function of material of filament of directly heated vacuum diode.	
Exercise 4.	To determine the Planck's constant using LEDs of at least 4 different colors.	
Exercise 5.	To determine the wavelength of H-alpha emission line of Hydrogen atom.	
Exercise 6.	To determine the ionization potential of mercury.	
Exercise 7.	To determine the absorption lines in the rotational spectrum of Iodine vapor.	
Exercise 8.	To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.	
Exercise 9.	To setup the Millikan oil drop apparatus and determine the charge of an electron.	
Exercise 10.	To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.	
Exercise 11.	To setup the Millikan oil drop apparatus and determine the charge of an electron.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House. 2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers 3. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal.	

Course Code **DBSPDS601T24**	**Molecular Modelling & Drug Design**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Define the classification of chemical reaction.	
CO 2	Understanding of molecular modelling.	
CO 3	Apply the concept of molecular dynamics.	
CO 4	Classify the methods for comparative Modeling.	
CO 5	Analyze the results of assimilation and estimating Errors.	
CO 6	Develop the methods for Structure Prediction and Drug Design.	
Course Content		
Block I	**Introduction to Molecular Modelling:** Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.	
Block II	**Force Fields & Energy Minimization and Computer Simulation** Force Fields: Fields. Bond Stretching. Angle Bending. Introduction to non-bonded interactions. Electrostatic interactions. Van-der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water. Energy Minimization and Computer Simulation: Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.	
Block III	**Molecular Dynamics & Monte Carlo Simulation:** Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant Temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers	
Block IV	**Structure Prediction and Drug Design** Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemoinformatics – QSAR	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001. 2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997. 3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer – Anamaya Publishers, 2008.	

Course Code **DBSPDS602T24**	**Nanotechnology and Applications**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Explain the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.	
CO 2	Analyze synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nano rods, nanowires), thin films, nano porous materials, and nanostructured bulk materials.	
CO 3	Describe how different lithography methods can be used for making nanostructures.	
CO 4	Apply a theoretical background within synthesis/fabrication of nano materials which makes he/she prepared for later literature studies and laboratory work within the field.	
CO 5	Understand the applications of nanotechnology in different aspects of day to day life.	
CO 6	Develop scientific understanding of application of nanomaterials and nanotechnology in agriculture, health and environmental conservation.	
Course Content		
Block I	**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.	
Block II	**Fabrication techniques of nanomaterials** 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, Preparation through colloidal methods. MBE growth of quantum dots.	
Block III	**Characterization techniques and optical properties of nanomaterials** Characterization: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy. Scanning Tunneling Microscopy. Optical properties: Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure, Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals.	

Block IV	**Applications of nanoparticles** Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of hetero structures and nanostructures. Electron transport: Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission. Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation).
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books	1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.). 2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company) 3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited). 4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons). 5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007). 6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

Course Code **DBSPDS603T24**	**Numerical Methods**	**C-3**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand the nature and operations of Numerical Analysis, demonstrate familiarity with theories and concepts used in Numerical Analysis	
CO 2	Identify the steps required to carry out a piece of research on a topic in Numerical Analysis	
CO 3	Derive Numerical Methods	
CO 4	Study their convergence rate and performance, applicability of the methods on different test examples.	
CO 5	Recognize and apply appropriate theories, principles and concepts relevant to Numerical Analysis.	
CO 6	Develop the concept of algorithem.	
Course Content		
Block I	Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation Numerical solution of algebraic and transcendental equations Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method. Rate of convergence of these methods.	
Block II	Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton Gregory forward and backward difference interpolation.	
Block III	Numerical differentiation: forward difference, backward difference and central Difference. Newton Integration: trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rule	
Block IV	LU decomposition, Gauss elimination and iterative methods for solving system of linear algebraic simultaneous equations. Solution of ordinary differential equations of first order with initial and boundary conditions using Picard's, Euler's, Euler's modified method and Runge-kutta method	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007. 2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering 3. Computation, 6^{th} Ed., New age International Publisher, India, 2007. 4. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008. 5. Bansal & Ojha, 1989 (First Edition), "Numerical Analysis" JPH Publication, Jaipur. 6. S S Shastri, 2003 (First Edition), " Numerical Analysis", New Age Publication, New Delhi.	

Course Code **DBSPDS601P24**	**Molecular Modelling & Drug Design lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the theoretical background of computational techniques and selective application to various molecular systems.	
CO 2	Perform minimization methods through use of different force fields.	
CO 3	Calibrate ESP Plots by suitable soft wares, electron rich and electron deficient sites,	
CO 4	Compare computational and experimental results and explain deviations.	
CO 5	Design Optimization of geometry parameters of a molecule (such as shape, bond length and bond angle) through use of software like Chem Sketch and Argus Lab in interesting hands-on exercises.	
Exercises		
Exercise 1.	Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.	
Exercise 2.	a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of cis and trans 2-butene.	
Exercise 3.	Visualize the electron density and electrostatic potential maps for LiH, HF, N2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.	
Exercise 4.	a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.	
Exercise 5.	Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide	
Exercise 6.	(a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.	
Exercise 7.	Arrange 1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.	
Exercise 8.	(a) Compare the optimized bond angles H2O, H2S, H2Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.	
Learner support Material	Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.	
Text books	1. Lewars, E. (2003), Computational Chemistry, Kluwer academic Publisher. 2. Cramer, C.J. (2004), Essentials of Computational Chemistry, John Wiley & Sons. 3. Hinchcliffe, A. (1996), Modelling Molecular Structures, John Wiley & Sons. 4. Leach, A.R. (2001), Molecular Modelling, Prentice-Hall.	

Course Code **DBSPDS602P24**	**Nanotechnology and Applications lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Follow the principles of basic science concepts in understanding, analysis and prediction of matter at Nano scale.	
CO 2	Perform Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer	
CO 3	Demonstrate a thin film capacitor and measure capacitance as a function of temperature or frequency.	
CO 4	Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.	
CO 5	Develop the advanced ideas and techniques required in emergent area of nanotechnology.	
Exercises		
Exercise 1.	Synthesis of metal nanoparticles by chemical route. Synthesis of semiconductor nanoparticles.	
Exercise 2.	Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.	
Exercise 3.	Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.	
Exercise 4.	Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.	
Exercise 5.	To prepare composite of CNTs with other materials.	
Exercise 6.	Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.	
Exercise 7.	XRD pattern of nanomaterials and estimation of particle size. Growth of quantum dots by thermal evaporation.	
Exercise 8.	Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.	
Exercise 9.	To study the effect of size on color of nanomaterials.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.). 2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company). 3. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited). 4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).	

Course Code **DBSPDS603P24**	**Numerical Methods lab**	**C-1**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Compare the computational methods for advantages and drawback, choose the suitable computational method among several existing methods	
CO 2	Implement the computational methods using any of existing programming languages	
CO 3	Perform methods and compare between them, identify the suitable computational technique for a specific type of problems and develop the CO4: Demonstrate computational method that is suitable for the underlying problem.	
CO 4	Develop the concept of Numerical Analysis Techniques, work effectively both in a team and independently	
CO 5	Apply the best computational methods to solve real-life and Engineering applications via computational packages such as MATLAB.	
Exercises		
Exercise 1.	Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/N.	
Exercise 2.	To find the absolute value of an integer.	
Exercise 3.	Enter 100 integers into an array and sort them in an ascending order.	
Exercise 4.	Bisection Method.	
Exercise 5.	Newton Raphson Method.	
Exercise 6.	Secant Method.	
Exercise 7.	Regulai Falsi Method, LU decomposition Method. Gauss-Jacobi Method. SOR Method or Gauss-Siedel Method. Lagrange Interpolation or Newton Interpolation. Simpson's rule.	
	Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.	
Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	
Text books	1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering 2. Computation, 6_{th} Ed., New age International Publisher, India, 2007. 3. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008. 4. Bansal& Ojha, 1989 (First Edition), "Numerical Analysis" JPH Publication, Jaipur. 5. S S Shastri, 2003 (First Edition), " Numerical Analysis", New Age Publication, New Delhi.	

Course Code **DBSPVA601T24**	**Fundamental of Indian Constitution**	**C-2**
Course Outcomes	After completion of this course, a student will be:	
CO 1	Understand the key aspects of the Indian Constitution	
CO 2	Comprehend the structure and philosophy of the Constitution	
CO 3	Understand the power and functions of various constitutional offices and institutions.	
CO 4	Realize the significance of the constitution and appreciate the role of constitution and citizen oriented measures in a democracy.	
Course Content		
Block I	**Indian Constitution: Making and basic premise** Meaning and Significance of Constitution. Constituent Assembly- Composition, Objectives Preamble and Salient features of the Indian Constitution. Fundamental Rights, Fundamental Duties. Directive Principle	
Block II	**Union and State Government** President of India- Election, Powers and functions Prime Minister and Cabinet – Structure and functions Governor- Powers and functions Chief Minister and Council of Ministers – Functions.	
Block III	**Legislature and Judiciary** Parliament – Lok Sabha and Rajya Sabha – Composition and powers, State Legislative Assembly and Legislative Council – Composition and powers .Judicial System in India – Structure and features . Supreme Court and High Court: Composition, Jurisdiction.	
Block IV	**Governance and Constitution** Federalism in India - Features Local Government - Panchayats –Powers and functions; 73rd and 74th amendments .Election Commission – Composition, Powers and Functions; Electoral Reforms . Citizen oriented measures – RTI and PIL – Provisions and significance.	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc. Lectures/ Tutorials/ Interactive Sessions/ Self-guided Learning Materials/ Open Educational Resources (as reference materials)/ Practical Exercises/ Assignments/ Seminars/ Group Discussions and Week-end Counselling.	
Text books	1. Durga Das Basu, Introduction to the Constitution of India, Gurgaon; LexisNexis, (23rd edn.) 2018. 2. M.V. Pylee, India's Constitution, New Delhi; S.Chand Pub., (16th edn.) 2017. 3. J.N. Pandey, The Constitutional Law of India, Allahabad; Central Law Agency,(55th edn.) 2018. 4. Constitution of India (Full Text), India.gov.in., National Portal of India, https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf	

	5. K B Merunandan, Bharatada Samvidhana Ondu Parichaya, Bangalore, Meragu Publications, 2015. 6. K. Sharma, Introduction to the Constitution of India, Prentice Hall of India, NewDelhi, 2002. 7. P.M Bakshi, Constitution of India, Universal Law Publishing House, New Delhi, 1999. 8. D.C. Gupta, Indian Government and Politics, Vikas publishing House, New Delhi,1975. 9. S.N. Jha, Indian Political System: Historical Developments, Ganga Kaveri Publishing House, Varanasi, 2005. 10. Arora & Mukherji, Federalism in India, Origin and Developments, Vikas Publishing House, New

Exit option with B.Sc.in PCM

* Credits of Open Elective courses can be obtained from MOOC and SWAYAM courses

Annexure II- Mandatory Documents for Admission

To be uploaded on the Online Admission Portal by the Prospective students

Admission Documents	Format (Jpeg/PNG/PDF)	Documents Size
Duly filled online application form with student signature	Digital signature/Student signature JPEG/PNG	20 KB
Colour scan copy of all year/semester mark sheet/grade cards (for PG programs only) or consolidated mark sheet/grade cards also accepted.	PDF/JPEG	500 KB
Colour scan copy of 10th std. Mark sheet/grade card	PDF/JPEG	
Colour scan copy of 12th std./ Three-Year Polytechnic Diploma Mark sheet/grade card	PDF/JPEG	
Colour scan copy of passport size photograph	JPEG or PNG Format	50 KB
Colour scan copy of Govt. Photo id proof, Aadhar card is mandatory. (Other options: Voter's id, Driving License, Passport etc.)	PDF/JPEG	100 KB
In case of name change, Gazette notification documents for name changes For married women – marriage certificate would be accepted – provided previous maiden name is clearly mentioned in the same. In case of deferred Father name or mother name in such cases without a Gazette notification document.	PDF	500 KB
If foreign student: colour scan copy of passport	PDF/JPEG	500 KB
Fees submission transaction details or receipt as per University policy for respective programs	PDF/JPEG	500 KB
Digitally Signed undertaking as per the process; where applicable	PDF	500 KB

Students can also visit the University website for the said information.

Annexure III- Academic Bank of Credit Id Creation Process

All enrolled students, particularly those of Indian nationality, are required to register with ABC (Academic Bank of Credits), a central scheme established by the Ministry of Education, Government of India, for depositing credit. ABC ID creation is mandatory for all students, ensuring their participation in this scheme.

Process	● Students can register by logging in at www.abc.digilocker.gov.in ● Click on My Account → Login as Student ● Click on "Sign up with DigiLocker" → Enter valid mobile number → An OTP is sent at the phone number via SMS → Enter the OTP and click on "Continue" button → Enter Security PIN set created during Sign Up and click "Submit" Button ● You will be prompted with ABC student account creation window
Documents and proofs required	● Aadhaar Card is mandatory for ABC Id creation ● Learners Name ● Date of Birth ● Gender ● Enrolment Number ● Requirements by Academic Institution: ● Mobile Number

The ABC Id can be created by students themselves using Digi-locker, UMANG application, ABC portal or Academic Institution Portal. The process for which is provided below.

The University will extend support to the students to create ABC ID. The documents required will remain the same as stated above.

Annexure IV – Continuous Internal Assessment Pattern

Particular	A1 (Objective Type)	A2 (Objective Type)
Marks	15	15

Question Pattern for the CIA Components
A-1 1.There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark 1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers. **A-2** 1. There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark 1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers.

Annexure V – End-term Examination Pattern

JNU

Centre for Distance and Online Education

End Term Examination

[PROGRAM NAME]

[COURSE NAME][COURSE CODE]

Time : 2 Hours	Max. Marks : 70
Note for students: The paper will comprises of 70 compulsory objective questions of 1 mark each.	
Answer all the questions. Each question carries one mark.	
Q. No. 1 to Q. No. 70 - Objective questions with four multiple choices.	