Scheme of Examination

&
Syllabii

Bachelor of Science/Master of Science
(Dual Degree programme) with Major Disciplines
(a) Physics
(b) Chemistry
(c) Mathematics

Academic Session 2024-25

in accordance with the

New National Education Policy

University School of Basic and Applied Sciences
GGS IP University
Sector 16-C, Dwarka
New Delhi-110078

1. Detailed syllabi for the Scheme for all three disciplines for the first year (**two semesters**) - **Physics, Chemistry and Mathematics**

2. Scheme framework and the course names for the higher semesters **(IIIrd - Xth Semesters**) for major disciplines in **Physics, Chemistry and Mathematics.**

Approval History:

1. First year Scheme and Syllabus approved by BOS: ——————
2. First year Scheme and Syllabus approved by AC Subcommittee: ___
3. First year Scheme and Syllabus approved by AC: _____

(a) The BSc-MSc programme will be of **10 semesters duration**. Each academic year will have 2 semesters.

(b) The first year (i.e. the first 2 semesters) will consist of foundation courses.

(c) The 2nd, 3rd and 4th year courses will be specialised as will be the final 5th year (for an MSc degree) . In keeping with the spirit of NEP, the courses are categorised as DSC-Discipline Specific Core ; DSE-Discipline Specific Elective; SEC-Skill Enhancement course; AEC-Ability Enhancement Course; VAC Value Added Course. An overall emphasis will be on holistic education and a strong foundation.

(d) In keeping with the spirit of NEP, there will be a provision for multiple entry and exit options: (i) At the end of three years a student has the option of getting a BSc degree in **one** of the three major disciplines: **(a) Chemistry (b) Mathematics (c) Physics and the option of also getting a minor specialisation in one of the three disciplines or any other minor streams offered.**
(ii) At the end of four years a student can get a "BSc (Hon) degree with Research" in one of the three major disciplines: **(a) Chemistry, (b) Mathematics (c) Physics** and the option of **also getting a minor specialisation in one of the three disciplines or any other minor streams offered.**
(iii) At the end of five years a student gets a Masters degree in one of the three major disciplines: **(a) Chemistry, (b) Mathematics (c) Physics with Research**
(iv) The scheme incorporates CBCS (Choice based Credit System) via choices of courses in various categories

A well rounded and holistic science education is the need of the hour and opens the road to a wide range of careers in both academia and industry. The basic and applied sciences are at the frontline of many futuristic technologies and careers. Further, in the light of the emphasis on holistic, multidisciplinary and broad based education via NEP in all programmes of study, the foundation courses in the sciences offered in the first year of these programmes will also be available to be part of all other programmes of study like degrees in the liberals arts, humanities and programmes which involve disciplines like management, law, architecture, design, engineering, education, etc. In the spirit of NEP a blended mode of teaching, MOOCs, CBCS and a broad base of options will be at the heart of this programme.

This document describes the curriculum of the Dual Degree (Bachelor of Science / Master of Science) Programmes that will be offered at the University School of Basic & Applied Sciences, GGS IP University in its own campus (not at the affiliated institutions of the University). In the event of any difficulty of implementation, and / or interpretation of any clause of the document, the same may be brought to the notice of Dean of the University School of Basic & Applied Sciences. The decision of the Dean, University School of Basic & Applied Sciences shall be final and implemented to resolve the issue. The same shall be put up in the subsequent meeting of the Board of Studies of the University School of Basic & Applied Sciences for its approval. If the decision of the Board of Studies of the University School of Basic & Applied Sciences is at variance with the decision taken earlier

by the Dean of the School, the decision of the Board shall be effective from the date of the approval by the Board of Studies. In the interim period (between the approval of the Dean, of the School and the Board of Studies approval), the decision already taken by the Dean of the school shall stand.

The intake in the programme shall be **60 in each discipline (i.e. total of 180 students)** including reserved/ supernumerary seats as per the policy of the university.

Acronyms:

APC: Academic programme committee of the School
BOS: Board of Studies of the school
USBAS: University School Basic & Applied Sciences.
C: Number of credits assigned to a course / paper
COE: Controller of Examinations of the Examinations Division of the University.
SGPA/CGPA: Semester/Cumulative Grade Point Average.
NUES: No exam will be conducted by the University Examination Branch.
DSC: Discipline Specific Core Course
DSE: Discipline Specific Elective Course
SEC: Skill Enhancement Course
AEC: Ability Enhancement Course
VAC: Value Addition Course
L: Lectures
T/P: Tutorials/Practical
USS: University Schools of Study

Eligibility Criteria

Eligibility Criteria

Candidates must have passed intermediate (10+2) or its equivalent examination recognised by the concerned state/central government and education board with **Physics, Chemistry and Mathematics and English individually**.Further, the student should have obtained 50% marks taken together in Physics, Chemistry and Mathematics in the aforesaid qualification examination in the case of General Category.

Candidates belonging to Scheduled Castes/Scheduled Tribes/Widows or Wards of Defence Personnel / Persons with Disability will be allowed 5% relaxation of marks in the minimum eligibility requirement or as specified by the statutory body governing the programme of study, irrespective of the fact whether there exists any reservation for any category of such candidates or not.

Admission Criteria

All applicants are required to appear for the **Joint Entrance Exam [JEE] Main Paper I** Conducted by the National Testing Agency (NTA) **OR** the **Common University Entrance Test CUET (UG)** in **Physics, Chemistry and Mathematics** conducted by the National Testing Agency (NTA). The University will not conduct its own entrance exam for admissions but will be utilising the merit of JEE Main Paper I or CUET for admissions. The admissions would be based on merit/rank obtained in the aforesaid exams. The first p**riority will be given to applicants qualifying the JEE Main Paper I, after this is exhausted, the next priority will be given to CUET qualified candidates. For seats vacant after exhausting the list of JEE Main Paper I and CUET qualified candidates, admissions will be done based on the merit of the qualifying examination (12th standard) . The relaxation in eligibility will be as per the rules of the University.**

The eligibility and admission criteria and procedures may change as per the University's policies from time to time.

Bachelor of Science/Master of Science
(Dual Degree programme) with Major Disciplines
(a) Physics
(b) Chemistry
(c) Mathematics

Programme Outcomes

1. **PO1:** Students acquire the necessary skills and exposure in the sciences for a holistic development and become valuable community members and citizens.
2. **PO2:** Students imbibe the necessary qualities that can enable them to adapt to the changing world, communicate with and understand other members of the community and have a broadened perspective.
3. **PO3:** Students attain real world experiences and problem-solving skills within and beyond the curriculum, learn critical thinking and have the necessary training to be lifelong learners.
4. **PO4:** Students learn to interlink knowledge, skills, values and attitudes towards developing a more unified world view.

Programme Specific Outcomes

1. **PSO1:** Students are exposed to holistic science education in Physics, Chemistry and Mathematics which opens doors to many avenues in academia, industry and beyond.
2. **PSO2:** Students acquire strong fundamental knowledge of the basic sciences which form the foundation for applied and technical fields.
3. **PSO3**: Students learn to think up of, formulate and solve and analyse problems theoretically and practically through experiments in Physics, Chemistry and Mathematics, thus developing valuable skills.
4. **PSO4:** Students have a rich exposure to interdisciplinary and multidisciplinary areas, helping them think out of the box and develop a broad understanding

The new curriculum framework has the following features, as per UGC guidelines:

i. Flexibility to move from one discipline of study to another.

ii. Opportunity for learners to choose the courses of their interest in all disciplines.

iii. Facilitating multiple entry/exit with UG certificate/diploma/degree depending on the number of credits earned.
iv. Flexibility for learners to move from one institution to another to enable them to have multi and/or interdisciplinary learning;

v. Flexibility to switch to alternative modes of learning (offline, ODL, and Online learning, and hybrid modes of learning).

Definitions, Eligibility, and Duration of the Programme
Semester/Credits:

- A semester comprises 90 working days and an academic year is divided into two semesters.
- The summer term is for eight weeks during summer vacation. Internship/apprenticeship/work-based vocational education and training can be carried out during the summer term, especially by students who wish to exit after two semesters or four semesters of study. Regular courses may also be offered during the summer on a fast-track mode to enable students to do additional courses or complete backlogs in coursework. The HEIs can decide on the courses to be offered in the summer term depending on the availability of faculty and the number of students.

Major and Minor disciplines

Major discipline is the discipline or subject of main focus and the degree will be awarded in that discipline. Students should secure the prescribed number of credits (about 50% of total credits) through core courses in the major discipline.
Minor discipline helps a student to gain a broader understanding beyond the major discipline. For example, if a student pursuing a Physics major obtains a minimum of 24 credits from a bunch of courses in statistics , then the student will be awarded BSc degree in Physics with a Minor in statistics; or if a student of Physics obtains a minimum of 24 credits from one theme such as Quantum Information or Nanoscience or Material Science , the student will be awarded BSc degree in Physics with a Minor in the concerned field.

Awarding UG Certificate, UG Diploma, and Degrees

UG Certificate: Students who opt to exit after completion of the first year and have secured minimum **46 credits** will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

UG Diploma: Students who opt to exit after completion of the second year and have secured a minimum **78** credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

3-year UG Degree: Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing **117** credits and satisfying the minimum credit requirements as given in the table.

4-year UG Degree (Honours): A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with **149** credits and have satisfied the minimum credit requirements as given in table.

4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure **149** credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

UG Degree Programmes with Single Major: A student has to secure a minimum of 50% credits from the major discipline for the 3-year/4-year UG degree to be awarded a single major. For example, in a 3-year UG programme, if the total number of credits to be earned is **117** , a student of Physics with a minimum of **58** credits will be awarded a BSc in Physics with a single major. Similarly, in a 4-year UG programme, if the total number of credits to be earned is **149**, a student of Physics with a minimum of **74** credits will be awarded a BSc. (Hons./Hons. with Research) in Physics in a 4-year UG programme with single major.

UG Degree Programmes with Minor Stream is the discipline or subject other than the discipline or subject in which the student is pursuing Major. If a student earns **24 credits** for a 3-year degree and **32 credits** for a 4-year degree from a discipline other than the Major stream, the student will be awarded with Minor in the said stream.

Duration of the Programme

i. The duration of the UG programme is 4 years or 8 semesters. Students who desire to undergo a 3-year UG Programme will be allowed to exit after completion of the 3rd year. If a student wants to leave after the completion of the first or second year, the student will be given a UG Certificate or UG Diploma, respectively, provided they secure the prescribed number of credits (as given in table). Students who exit with a UG certificate or UG diploma are permitted to re-enter within three years and complete the degree programme.

ii. Students may be permitted to take a break from the study during the period of study but the total duration for completing the programme shall not exceed 7 years.

SN	Broad Category of Courses	Minimum Credit Requirement				
		1-year UG (CERTIFICATE)	**2-year UG (DIPLOMA)**	**3-year UG**	**4-Year UG (with Research)**	**4-Year UG (without Research)**
1	Major (Core) **DSC**	24	42	70	90	90
2	Minor Stream	8 (optional)	16 (optional)	24 (optional)	32(optional)	32(optional)
3	Multidisciplinary **(IDC)**	6	12	12	12	12
4	Ability Enhancement Courses **(AEC)**	4	8	10	10	10
5	Skill Enhancement Courses **(SEC)**	6	9	9	9	9
6	Value Added Courses common for all UG Programmes	4	4	4	4	4
7	Summer Internship	4	4	12	12	12
8	Research Project / Dissertation/Discipline Specific Electives**(DSE)**	——-	——-	-	12	12 credits of courses **(DSEs)**
	Total	**52 + 4 (summer internship) =56 credits for exit with certificate (minimum 48)**	**91+ 4 credits (summer internship) = 95 for exit with Diploma (minimum 79)**	**141 (minimum 117)**	**181 (minimum 149)**	**181 (minimum 149)**

TABLE 1

For clearing the various years to get the relevant degree, the minimum requirement for credits for MAJOR and MINOR specialisations will be as per UGC norms

SEMESTER-I

Discipline Specific Core (DSC) **(C- 2+2; UES)**	**Minor Stream** **Choose one from the basket of Minor streams each of 6 or 8 courses offered**	**Inter-disciplinary Courses (IDC)** **(C- 3; UES)** **Choose one FROM THE BASKET**	**Skill Enhancement Course (SEC)** **(C- 3; UES)** **Choose one FROM THE BASKET**	**Ability Enhancement Course (AEC)** **(C- 2; UES)** **Choose one FROM THE BASKET**	**Value Added Course/ Dissertation** **(C-2: NUES)** **Choose one FROM THE BASKET**	**Total Credits**
DSC - I (level 100) **DSC - IA (level 100)** 1. PHYSICS-I + PHYSICS LAB-I **[3+1=4 Credits]** **DSC - I (level 100)** 2. CHEMISTRY-I+ CHEM LAB-I **[2+2 =4 Credits]** **DSC - IC (level 100)** 3.MATHEMATICS-I **[3+1 =4 Credits]** **Credits: 12**	**MC-1 (level 100)** **Credits: 4**	**IDC -I** **MOOCs** **Credits: 3**	**SEC -I** **Credits 3**	**AEC – I** **Credits 2**	**VAC-I** **Credits 2**	**Total Credits 26**

SEMESTER-II

Discipline Specific Core (DSC) **(C- 2+2; UES)**	**Minor Stream** **Choose one from the basket of Minor streams each of 6 or 8 courses offered**	**Inter-disciplinary Courses (IDC)** **(C- 3; UES)** **Choose one FROM THE BASKET**	**Skill Enhancement Course (SEC)** **(C- 3; UES)** **Choose one FROM THE BASKET**	**Ability Enhancement Course (AEC)** **(C- 2; UES)** **Choose one FROM THE BASKET**	**Value Added Course/ Dissertation** **(C- 2; NUES)** **Choose one FROM THE BASKET**	**Total Credits**
DSC - II (level 100) **DSC - IIA (level 100)** 1. PHYSICS-II + PHYSICS LAB-II [3+1=**4 Credits]** **DSC - IIB (level 100)** 2. CHEMISTRY-II+ CHEM LAB-II **[2+2 =4 Credits]** **DSC - IIC (level 100)** 3.MATHEMATICS-II **[3+1 =4 Credits]** **Credits: 12**	**MC-2 (level 100)** **Credits: 4**	**IDC -II** **MOOCs** **Credits: 3**	**SEC -II** **Credits 3**	**AEC – II** **Credits 2**	**VAC-II** **Credits 2**	**Total Credits 26**
Students exiting the programme after scoring a minimum of 48 credits will be awarded a UG certificate in the BASIC SCIENCES provided they secure 4 credits (included in the minimum 48 credits) in work based vocational courses offered during summer term						

SEMESTER-III (THE CHOICE OF THE MAJOR DISCIPLINE IS TO BE MADE IN SEM-III)

Discipline Specific Core(DSC) **(UES)** **CHOOSE ONE GROUP**	**Minor Stream** **Choose one from the basket of Minor streams each of 6 or 8 courses offered**	**Inter-disciplinary Courses (IDC)** **(C- 3; UES)** **Choose one FROM THE BASKET**	**Skill Enhancement Course (SEC)** **(C- 2; UES)** **Choose one FROM THE BASKET**	**Ability Enhancement Course (AEC)** **(C- 2; UES)** **Choose one FROM THE BASKET**	**Value Added Course/ Dissertation**	**Total Credits**
DSC - III (level 200) **DSC - IIIA (level 200)** 1a. PHYSICS-III - 3 1b. PHYSICS-III. -3 1c PHYSICS LAB-III **-3.** **Credits (TOTAL 9)** **DSC - IIIB (level 200)** 2a. CHEMISTRY-III -2 2bCHEMISTRY-III-2 2c CHEMISTRY-III -2 2d CHEM LAB-III-3 **Credits (TOTAL 9)** **DSC - IIIC (level 200)** 3a.MATHEMATICS-III -3 3b.MATHEMATICS-III-3 3c.MATHEMATICS-III-3 **Credits (TOTAL 9)** **Credits: 9**	**MC-3 (level 100)** **Credits: 4**	**IDC -III** **OR** **MOOCs** **Credits: 3**	**SEC -III** **Credits 2**	**AEC – III** **Credits 2**		**Total Credits 20**

SEMESTER-IV

Discipline Specific Core (DSC) (UES) **CHOOSE ONE GROUP**	**Minor Stream** **Choose one from the basket of Minor streams each of 6 or 8 courses offered**	**Inter-disciplinary Courses (IDC) (C- 3; UES) Choose one FROM THE BASKET**	**Skill Enhancement Course (SEC) (C- 3; UES) Choose one FROM THE BASKET**	**Ability Enhancement Course (AEC) (C- 2; UES)** **Choose one FROM THE BASKET**	**Value Added Course/ Dissertation**	**Total Credits**
DSC - IV (level 200) **DSC - IVA (level 200)** 1a. PHYSICS-IV - 3 1b. PHYSICS-IV -3 1c PHYSICS LAB-IV **-3. Credits (TOTAL 9)** **DSC - IVB (level 200)** 2a. CHEMISTRY-IV -2 2bCHEMISTRY-IV-2 2c CHEMISTRY-IV -2 2d CHEM LAB-IV-3 **Credits (TOTAL 9)** **DSC - IVC (level 200)** 3a.MATHEMATICS-IV-3 3b.MATHEMATICS-IV-3 3c.MATHEMATICS-IV-3 **Credits (TOTAL 9)** **Credits: 9**	**MC-4 (level 200)** **Credits: 4**	**IDC -IV** **OR** **MOOCs** **Credits: 3**	**SEC -IV** **Credits 3**	**AEC – IV** **Credits 2**		**Total Credits 21**
Students exiting the programme after securing a minimum of 79 credits will be rewarded a DIPLOMA in the BASIC SCIENCES (in the relevant discipline P/C/M) provided they secure 4 credits (included in the minimum 79 credits) in work based vocational courses offered during the summer term either in the first year or the second year						

SEMESTER-V

Discipline Specific Core (DSC) **(UES) Choose one group of <u>four</u> courses from the list**	**Minor Stream** **Choose one from the basket of Minor streams each of 6 or 8 courses offered**	**Inter-disciplinary Courses (IDC)**	**Skill Enhancement Course (SEC)**	**Ability Enhancement Course (AEC)** **(C- 2; UES)**	**Value Added Course/ Dissertation**	**Total Credits**
DSC-V 1a. PHYSICS-V **[4 credits]** 1b. PHYSICS-V **[4 credits]** 1c PHYSICS-V **[4 credits]** 1d. PHYSICS-V (PHYSICS LAB) **[2 credits]** 2a. CHEMISTRY-V + CHEMISTRY-V LAB **[3+2=5 credits]** **2**b. CHEMISTRY-V + CHEMISTRY-V LAB **[3+2=5 credits]** **2c** CHEMISTRY-V + CHEMISTRY-V LAB **[3+2= 5 credits]** (TOTAL = 15 CREDITS) **3**a. MATHEMATICS-V[4 credits] **3**b. MATHEMATICS-V **[4 credits]** **3**c. MATHEMATICS -V[4 credits] 3d. MATHEMATICS-V MATHEMATICS LAB) **[2 credits]** **Credits: 14**	**MC-5 (level 200)** **Credits: 4**			INTERNSHIP/ WORKSHOP 2 credits		**TOTAl CRED-ITS =20**

SEMESTER-VI

Discipline Specific Core (DSC) **Choose one group of <u>four</u> courses from the list**	**Minor Stream** **Choose one from the basket of Minor streams each of 6 or 8 courses offered**	**Inter-disciplinary Courses (IDC)** **(C- 3+1; UES)** **Choose one**	**Skill Enhancement Course (SEC)** **(C- 3; UES)**	**Ability Enhancement Course (AEC)** **(C- 2; UES)**	**Value Added Course/**	**Total Credits**
DSC-VI 1a. PHYSICS-VI **[4 credits]** 1b. PHYSICS-VI **[4 credits]** 1c PHYSICS-VI **[4 credits]** 1d. PHYSICS-VI (PHYSICS LAB) **[2 credits]** 2a. CHEMISTRY-VI + CHEMISTRY-VI LAB **[3+2=5 credits]** **2**b. CHEMISTRY-VI + CHEMISTRY-VI LAB **[3+2=5 credits]** **2c** CHEMISTRY-VI + CHEMISTRY-VI LAB **[3+2= 5 credits]** (TOTAL = 15 CREDITS) **3**a. MATHEMATICS-VI[4 credits] **3**b. MATHEMATICS-VI **[4 credits]** **3**c. MATHEMATICS -VI[4 credits] 3d. MATHEMATICS-VI MATHEMATICS LAB) **[2 credits]** **Credits: 14**	**MC-6 (level 200)** **Credits: 4**					**TOTAl CRED-ITS =18**
After the completion of three years and scoring a minimum of 117 credits (out of total 141credits) students will be awarded a UG degree in the relevant discipline as MAJOR and if 24 credits are additionally earned from the minor stream, a degree in the relevant MINOR. Minimum requirement for credits for getting MAJOR and MINOR specialisations will be as per UGC norms						

SEMESTER-VII

SE-MESTER	Discipline Specific Core (DSC) (UES) Choose one group of four courses from the list	Minor Stream Choose one from the basket of Minor streams each of 6 or 8 courses offered	Inter-disciplinary Courses (IDC)	Skill Enhancement Course (SEC)	Ability En-hancement Course (AEC)	Value Added Course/ Dissertation	Total Credits
VII	**DSC-VIII (level 400)** 1a. PHYSICS-VII **[4 credits]** 1b. PHYSICS-VII **[4 credits]** 1c PHYSICS-VII **[4 credits]** 1d. PHYSICS-VII (PHYSICS LAB) **[4 credits]** 2a. CHEMISTRY-VII + CHEMISTRY-VII LAB **[3+2=5 credit** **2**b. CHEMISTRY-VII+ CHEMISTRY-VII LAB **[3+2=5 credits]** **2c** CHEMISTRY-VII + CHEMISTRY-VII LAB **[3+2= 5 credits]** (TOTAL = 15 CREDITS) **3**a. MATHEMATICS-VII[4 credits] **3**b. MATHEMATICS-VII **[4 credits]** **3**c. MATHEMATICS -VII[4 credits] 3d. MATHEMATICS-VII MATHEMATICS Theory/ LAB) **[4 credits]** **Credits: 16**	**MC-7 (level 300)** **Credits: 4**					**TOTAL CRED-ITS =20**

Scheme A SEMESTER - VIII (for students wanting to pursue research)

SE-MESTER	Discipline Specific Electives (DSE) (UES) Choose one ELECTIVE course from the relevant list	Minor Stream Choose one from the three	Inter-disciplinary Courses (IDC)	Skill Enhancement Course (SEC)	Ability Enhance-ment Course (AEC)	Research Project and dissertation	Total Credits
VIIIA	DSE-VIII (LEVEL 400) * BASKET OF ELECTIVE COURSES EACH OF 4 CREDITS Credits: 4	MC-8 (level 300) Credits: 4				RESEARCH PROJECT/ DISSERTA-TION Credits: 12	Total Credits =20
After the completion of four years and a minimum of 149 credits (out of a total of 181 credits), students will be awarded a UG degree (Honours) in the relevant discipline (MAJOR with/without MINOR) WITH RESEARCH. If 32 credits are additionally earned from the minor stream, students will be awarded a UG degree (Honours) in the relevant discipline (MAJOR with/without MINOR) WITH RESEARCH. Minimum requirement for credits for getting MAJOR and MINOR specialisations will be as per UGC norms							

*** DSE-VIII (Level 400) : The basket of electives for DSE-VIII will be finalised later, depending on the specialisations and expertise of Faculty**

SCHEME B SEMESTER - VIII (FOR STUDENTS NOT pursuing RESEARCH)

SE-MESTER	Discipline Specific Electives (DSE) (UES) Choose FOUR ELECTIVE courses from the relevant list OF ELEC-TIVE COURSES OFFERED	Minor Stream Choose one from the three	Inter-disciplinary Courses (IDC)	Skill Enhancement Course (SEC)	Ability Enhancement Course (AEC)	Value Added Course/ Research project and Dissertation	Total Credits
VIIIB	DSE-VIII* (LEVEL 400) BASKET OF ELECTIVE COURSES EACH OF 4 CREDITS Credits: 16	MC-8 (level 300) Credits: 4					TOTAL CREDITS 20
After the completion of four years and a minimum of 149 (out of a total of 180 credits), students will be awarded a UG degree (Honours) in the relevant discipline (MAJOR with or without MINOR). If 32 credits are additionally earned from the minor stream, students will be awarded a UG degree (Honours) in the relevant discipline (MAJOR with or without MINOR). STUDENTS NOT OPTING FOR RESEARCH WILL TAKE 4 ELECTIVE COURSES OF 4 CREDITS EACH (16 CREDITS). Minimum requirement for credits for getting MAJOR and MINOR specialisations will be as per UGC norms							

*** DSE-VIII (Level 400) : The basket of electives for DSE-VIII will be finalised later, depending on the specialisations and expertise of Faculty**

SEMESTER-IX (MSC PHYSICS/CHEMISTRY/MATHEMATICS)			
SEMESTER-IX	**DISCIPLINE SPECIFIC CORE (CHOOSE ONE DSC)**	**DISCIPLINE SPECIFIC ELECTIVE(CHOOSE ONE)**	**Credits**
IX	**DSC IX* 1. CHEMISTRY 2. MATHEMATICS 3. PHYSICS**	**DSE-IX* (One Elective to be chosen from a BASKET of Electives in the concerned discipline)**	**8**
IX	**MAJOR RESEARCH PROJECT PHASE-I**		**14**
Total			**22**

*** DSC-IX AND DSE-IX: DSC-IX and the basket of electives for DSE-IX will be finalised later, depending on the specialisations and expertise of Faculty**

SEMESTER-X (MSC PHYSICS/CHEMISTRY/MATHEMATICS)			
SEMESTER-X	**DISCIPLINE SPECIFIC CORE (CHOOSE ONE DSC)**	**DISCIPLINE SPECIFIC ELECTIVE(CHOOSE ONE)**	**Credits**
X	**DSC X* 1. CHEMISTRY 2. MATHEMATICS 3. PHYSICS**	**DCE-X* (One Elective to be chosen from a BASKET of Electives in the concerned discipline)**	8
X	**MAJOR RESEARCH PROJECT PHASE-II**		**14 + 2=16**
	VIVA VOCE		
Total			**24**
AFTER THE COMPLETION OF A TOTAL OF 46 CREDITS IN SEMESTERS IX AND X WHICH INCLUDES A RESEARCH PROJECT WITH DISSERTATION OF 30 CREDITS, THE STUDENT WILL GET A MASTERS DEGREE (MSc) IN PHYSICS/ CHEMISTRY/MATHEMATICS WITH RESEARCH. MINIMUM REQUIREMENT FOR CREDITS WILL BE AS PER UGC NORMS			

*** DSC-X and DSE-X : DSC-X and the basket of electives for DSE-X will be finalised later, depending on the specialisations and expertise of Faculty**

LIST OF DISCIPLINE SPECIFIC CORE COURSES AND DISCIPLINE SPECIFIC ELECTIVES FROM SEMESTER-I TO SEMESTER X

(PHYSICS, CHEMISTRY, MATHEMATICS)

Scheme of Discipline Specific Core (DSC)/Elective (DSE) Courses of B.Sc./M.Sc. (Dual Degree Programme) in the Discipline of Physics

Paper Code	SEMESTER	COURSE	L	P	Total Credit
BSP-101	SEM-1	Mechanics Theory/ Lab	**3**	**1**	**4**
BSP-102	SEM-2	Waves and Oscillations Theory / Lab	**3**	**1**	**4**
BSP-201	SEM-3	Optics	**3**	**0**	**3**
BSP-203	SEM-3	Electromagnetic Theory	**3**	**0**	**3**
BSP-251	SEM-3	Optics/ EM Lab	**-**	**3**	**3**
BSP-202	SEM-4	Mathematical Physics-I	**3**	**-**	**3**
BSP-204	SEM-4	Thermal Physics	**3**		**3**
BSP-252	SEM-4	Thermal Physics/Computational Physics & Programming Lab-I	**-**	**3**	**3**
BSP-301	SEM-5	Modern Physics	**4**		**4**
BSP-303	SEM-5	Mathematical Physics-II	**4**	**-**	**4**
BSP-305	SEM-5	Classical Mechanics	4	-	**4**
BSP-351	SEM-5	Modern Physics/ Computational Physics & Programming Lab--II	**-**	**2**	**2**

BSP-302	SEM-6	Electronics	4	-	**4**
BSP-304	SEM-6	Quantum Mechanics-I	4	-	**4**
BSP-306	SEM-6	Solid State Physics	4	-	**4**
BSP-352	SEM-6	Electronics / Solid State Physics Lab	-	2	**2**
BSP-401	SEM-7	Quantum Mechanics-II	4	-	**4**
BSP-403	SEM-7	Atomic Physics	4	-	**4**
BSP-405	SEM-7	Nuclear Physics	4	-	**4**
BSP-407	SEM-7	Electrodynamics	4	-	**4**
BSP-451	SEM-7	Atomic Physics /Nuclear Physics Lab	-	4	**4**
SCHEME A					
BSP-402	SEM-8	DSE-VIIIA	-	4	**4**
BSP-452	SEM-8	RESEARCH PROJECT	-	12	**12**
SCHEME B					
BSP-402	SEM-8	DSE-VIIIA	3	1	**4**
BSP-404	SEM-8	DSE-VIIIB	3	1	**4**
BSP-406	SEM-8	DSE-VIIIC	3	1	**4**
BSP-408	SEM-8	DSE-VIIID	3	1	**4**
BSP-501	SEM-9	DSC-IX	3	1	**4**
BSP-503	SEM-9	DSE-IX	3	1	**4**

BSP-551	SEM-9	MAJOR RESEARCH PROJECT (PHASE-I)	-	14	**14**
BSP-502	SEM-10	DSC-X	3	1	**4**
BSP-504	SEM-10	DSE-X	3	1	**4**
BSP-552	SEM-10	MAJOR RESEARCH PROJECT (PHASE-II) + VIVA VOCE	-	16	**16**

Scheme of Discipline Specific Core (DSC)/Elective (DSE) Courses of B.Sc./M.Sc. (Dual Degree Programme) in the Discipline of Chemistry

Paper Code	SEMESTER	COURSE	L	P	C
BSC-101	SEM-1	Atomic Structure & Chemical Bonding/Lab	2	2	**4**
BSC-102	SEM-2	Physical Organic Chemistry/Lab	2	2	**4**
BSC-201	SEM-3	s- and p-Block Elements	2	0	**2**
BSC-203	SEM-3	Hydrocarbons and Aromatic Hydrocarbons	2	0	**2**
BSC-205	SEM-3	States of Matter and Colligative Properties	2	0	**2**
BSC-251	SEM-3	LABORATORY - III	0	3	**3**
BSC-202	SEM-4	Coordination Chemistry	2	0	**2**
BSC-204	SEM-4	Oxygen Containing Functional Groups	2	0	**2**
BSC-206	SEM-4	Ionic Equilibria and Introduction to Thermodynamics	2	0	**2**
BSC-252	SEM-4	LABORATORY - IV	0	3	**3**
BSC-301	SEM-5	Organometallic Chemistry & its Applications	3	2	5
BSC-303	SEM-5	Nitrogen containing functional groups, Polynuclear Hydrocarbons and Heterocyclic compounds	3	2	**5**
BSC-305	SEM-5	Thermodynamics and Chemical Equilibria	3	2	**5**

BSC-302	SEM-6	Bioinorganic Chemistry	3	2	**5**
BSC-304	SEM-6	Biomolecules	3	2	**5**
BSC-306	SEM-6	Phase Equilibria and Electrochemistry	3	2	**5**
BSC-401	SEM-7	Symmetry and Distortions in molecules	3	2	**5**
BSC-403	SEM-7	Green Chemistry	3	2	**5**
BSC-405	SEM-7	Chemical Kinetics, Surface Chemistry and Photo-chemistry	3	2	**5**
SCHEME A					
BSC-402	SEM-8	Acids-Base Theories and metal oxides	4	-	4
BSC-452	SEM-8	RESEARCH PROJECT	-	12	12
SCHEME B					
BSC-402	SEM-8	Acids-Base Theories and metal oxides	4	0	4
BSC-404	SEM-8	Spectroscopy and Pharmaceutical Compounds	4	0	4
BSC-406	SEM-8	Quantum Chemistry and Spectroscopy	4	0	4

BSC-452	SEM-8	LABORATORY - VIII	0	4	4
BSC-501	SEM-9	DSC-IX	3	1	4
BSC-503	SEM-9	DSE-IX	3	1	4
BSC-551	SEM-9	MAJOR RESEARCH PROJECT (PHASE-I)	-	14	14
BSC-502	SEM-10	DSC-X	3	1	4
BSC-504	SEM-10	DSE-X	3	1	4
BSC-552	SEM-10	MAJOR RESEARCH PROJECT (PHASE-II) + VIVA VOCE	-	**16**	**16**

Scheme of Discipline Specific Core (DSC)/Elective (DSE) Courses of B.Sc./M.Sc. (Dual Degree Programme) in the Discipline of Mathematics

Paper Code	SE-MESTER	COURSE	L	T	P	C
BSM-101	SEM 1	Calculus	2	1	1	**4**
BSM-102	SEM 2	Linear algebra	2	1	1	**4**
BSM-201	SEM 3	Advanced calculus	2	0	1	**3**
BSM-203	SEM 3	Real analysis I	3	0	0	**3**
BSM-205	SEM 3	Ordinary Differential Equations- I	2	0	1	**3**
BSM-202	SEM 4	Real Analysis II	3	0	0	**3**
BSM-204	SEM 4	Ordinary differential Equations II	2	0	1	**3**
BSM-206	SEM 4	Analytical Geometry	2	1	1	**3**

BSM-301	SEM 5	Complex analysis I	3	1	0	**4**
BSM-303	SEM 5	Partial differential equation	2	1	1	**4**
BSM-305	SEM 5	Abstract algebra I	3	1	0	**4**
BSM-307	SEM 5	Matlab I	0	0	2	**2**
BSM-302	SEM 6	Complex analysis II	3	1	0	**4**
BSM-304	SEM 6	Optimization I	2	1	1	**4**
BSM-306	SEM 6	Abstract algebra II	3	1	0	**4**
BSM-308	SEM 6	Matlab II	0	0	2	**2**
BSM-401	SEM 7	Numerical Techniques	2	1	1	**4**
BSM-403	SEM 7	Mathematical Modelling	2	1	1	**4**
BSM-405	SEM 7	Fourier series and Transformation	3	1	0	**4**
BSM-407	SEM 7	Optimization-II	3	1	0	**4**

SCHEME A						
	SEM-8	DSE-IX	3	1	0	4
BSM-452	SEM-8	RESEARCH PROJECT	-	-	12	12
SCHEME B						
BSM-402	SEM-8	Laplace transformation	3	1	0	4
BSM-404	SEM-8	Numerical Applications	2	1	1	4
BSM-406	SEM-8	Dynamical systems	2	1	1	4
BSM-408	SEM-8	Differential Geometry	2	1	1	4
BSM-501	SEM 9	Graph theory (2+1+1)	2	1	1	4
BSM-503	SEM 9	Advanced linear algebra (3+1+0)	3	1	0	4
BSM-505	SEM 9	Industrial Mathematics (2+1+1)	2	1	1	4
BSM-507	SEM 9	Integral equation and Boundary value problem	3	1	0	4
BSM-551	SEM-9	MAJOR RESEARCH PROJECT (PHASE-I)	-	-	14	14

	SEM-10	DSC-X	3	1	0	4
	SEM-10	DSE-X	3	1	0	4
BSM-502	SEM-10	Topology	3	1	0	4
BSM-504	SEM-10	Non-linear programming	3	1	0	4
BSM-506	SEM-10	Financial Mathematics	3	1	0	4
BSM-508	SEM-10	Environmental modelling	2	1	1	4
BSP-552	SEM-10	MAJOR RESEARCH PROJECT (PHASE-II) + VIVA VOCE	-	-	**16**	**16**

SYLLABII FOR SEMESTER - I & SEMESTER-II

CORE COURSES

PHYSICS

Paper Code	SEMESTER	COURSES	L	P	Total Credit
BSP-101	SEM-1	Mechanics Theory/ Lab	3	1	4

Theory

Course Objectives:

CO1: To enable students to understand concepts and applications of Newton's laws.

CO2: To introduce the understanding of kinetic and potential energy.

CO3: To understand the mechanism of center of mass and inertia tensor.

CO4: To understand the concept of gravity.

Unit I

Review of Newton's Laws of Motion: Newton's First and Second Laws: Inertial Frames, Third law and conservation of momentum, Newton's second law in cartesian coordinates and two dimensional polar coordinates; Projectiles: Air resistance, linear air resistance, trajectory and range in a linear medium, quadratic air resistance; Centre of mass, angular momentum for single and several particles.

Unit II

Kinetic energy and work, potential energy and conservative forces, force as the gradient of potential energy; second condition that force F be conservative, time dependent potential energy; energy for linear one-dimensional systems, curvilinear one-dimensional systems; central forces, energy of interaction of two particles and multiparticle system

Unit III

Properties of the center of mass, rotation about a fixed axis, rotation about any axis: the inertia tensor, principal axes of inertia, Finding the principal axes: eigenvalue equations.the

Unit IV

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere; Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

References:

1. John R. Taylor, Classical Mechanics, University Science Books (2004)
2. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, McGraw-Hill (1973).
3. D.S. Mathur, Mechanics , S. Chand and Company Limited, (2000)
4. C.Kittel, W.Knight , Mechanics, Berkeley Physics, vol.1, Tata McGraw-Hill (2007)
5. H. Goldstein, C, Poole, J. Safko, Classical Mechanics, Addison Wesley (2000)

Course Expected Outcomes:

CEO1: Students will understand fundamental concepts

CEO2: Students will get an understanding of principles of mechanics and their role in real life situations

CEO3: Students will be able to understand the concept of centre of mass and moment of inertia

CEO4: Students will learn about gravity and its consequences.

Paper Code	SEMESTER	COURSES	L	P	Total Credit
BSP-101	SEM-1	Mechanics Theory/ Lab	3	1	4

Laboratory

Course Objectives: To expose students to a broad range of experimental techniques with an emphasis on mechanics. The experiment will be aimed to help correlate with the theoretical concepts of mechanics and hence offer a deeper understanding

List of Experiments:

1. To study concepts of Newton's First, Second and Third laws.

2. To study properties of projectile motion.

3. To study Kinetic energy, Potential energy, Work energy theorem and conservation of mechanical energy.

4. To study Rotational inertia of a ring, a disk and to study Torque.

5. To study Period of a Torsional pendulum and Torsional spring constant.To study the sum of the Torques is Zero, the sum of the forces is zero and the force of the weight of the meterstick acts as its center of mass.

6. To measure the Universal Gravitational Constant and recreate Cavendish's historical experiment.

7. To study conservation of momentum in elastic & inelastic collision, Kinetic energy is not conserved in inelastic collisions and Kinetic energy as magnetic potential energy in elastic collisions using magnetic bumpers.

8. To study Impulse-change in momentum, area under a force vs time curve and different shaped force curves for elastic and inelastic collisions.

9. To study the relationship between force and spring deformation, investigate both spring compression and extension and amount of energy stored in a spring.
10. To Study Centripetal force, Angular velocity and Periodic motion.
11. To Study How centripetal force depends on radius, mass, and speed.
12. To determine acceleration due gravity ‘g’ by bar pendulum.
13. To determine acceleration due gravity ‘g’ by Kater’s pendulum.
14. To determine moment of inertia of a fly wheel

In a semester, approximately 8 experiments from the above list will be selected.

References:

1. Harnam Singh, P.S. Hemne, B.Sc Practical Physics, S.Chand, Revised Edition (2009).

2. Geeta Sanon, B.Sc Practical Physics, R Chand & CO. New Delhi, 5t Edition (2013).
3. B.L.Flint & H.T.Worsnop, Advanced Practical Physics for students, 1971, Asia Publishing House.
4. Michael Nelson and Jon M. Ogborn Advanced level Physics Practicals, 4th Edition, reprinted 1985, Heinemann Educational Publishers
5. D.P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, 1985, Vani Publication.

Course Outcomes

Students will be enabled to demonstrate their ability to use the techniques in conducting scientific experiments and observations. Students will be able to assemble components independently to carry out required experiments to achieve results.

Paper Code	SEMESTER	COURSE	L	P	Total Credit
BSP-102	SEM-2	Waves and Oscillations Theory / Lab	3	1	4

Theory

Course Objectives

CO1: To enable students to understand concepts and applications of harmonic motion

CO2: To provide basic training related to coupled oscillations, dispersion and resonances.

CO3: To understand the mechanism of traveling waves and Fourier analysis of pulses.

CO4: To apply the concepts to practical devices.

Unit-I

Free Oscillations of Simple Systems: Free Oscillations of Systems with one and two degrees of freedom, Linearity and superposition principle, Beats; Free Oscillations of Systems with many degrees of freedom: Transverse modes of continuous string, General motion of continuous string and Fourier analysis, modes of a noncontinuous system with N degrees of freedom;

Unit-II

Forced oscillations: Simple Harmonic Motion, damped simple harmonic oscillator, forced oscillator, resonances in system with two degrees of freedom, filters; Coupled Oscillations: Stiffness or capacitance, normal coordinates, degrees of freedom; normal modes of vibration, general method for finding normal mode frequencies, matrices, eigenvectors and eigen values, mass or inductance coupling, coupled oscillations of a loaded string.

Unit-III

Traveling waves: Harmonic traveling waves in dimension and phase velocity, index of refraction; dispersion, impedance and energy flux. Modulations, Pulses and Wave packets: group velocity, pulses, Fourier analysis of pulses, Fourier analysis of a traveling wave packet.

Unit-IV

Longitudinal waves: Sound waves in gases, energy distribution; intensity of sound waves, longitudinal waves in a solid, applications to earthquakes, longitudinal waves in periodic structure, reflection and transmission of sound waves at boundaries, Fourier series for a periodic function and for any interval.

References:

1. H.J.Pain, The Physics of Vibrations and Waves, Wiley India Edition, 6th Edition (2008)

2. Frank S. Crawford Jr., Waves, Berkeley Physics Course- Volume 3, TMH Education Pvt. Ltd, 1st reprint (2011)

3. A.P. French, Vibrations and Waves, CRC press, 1st Edition (2003)

4. N.K. Bajaj, The physics of Waves and Oscillations, TMH, (1998)

5. Ajoy Ghatak, Optics, TMH, (2008)

6. Max Born and Emil Wolf, Principles of Optics, Pergamon Press, 7th Edn., (1999)

Course Expected Outcomes:

CEO1: Students will develop an understanding of wave motion

CEO2: Students will understand the various tools for analysing wave motion

CEO3: Students will understand the concept of travelling waves and their applications

CEO4: Students will develop a base and learn tools that are applied in various fields of study like solid state physics, quantum mechanics, laser physics, communication etc

Paper Code	SEMESTER	COURSE	L	P	Total Credit
BSP-102	SEM-2	Waves and Oscillations Theory / Lab	3	1	4

Laboratory

Course Objectives: To make students understand a broad range of experimental techniques and to enable them to demonstrate their ability to use the techniques in conducting scientific experiments and observations.

List of Experiments:

1. To study Resonant Modes of Oscillation, Period of Transfer of Oscillation energy between Coupled Pendula.
2. To study Resonance curves for an oscillator: amplitude Vs. frequency, Resonant frequency, Period of a pendulum, Effect of magnetic damping on shape of resonance curve and Phase difference between oscillator and driver at low, resonant and high frequencies.
3. To study Reflection, Refraction and determine index of refraction.
4. To study Speed of waves in a string, Speed of sound in air, Resonance in strings and air columns and Harmonics.
5. To investigate standing waves, to pull string to adjust number of segment and to vary frequency of vibration.
6. To study Speed of Wave Propagation, Superposition of Waves, Effects of Varying Water Depth.
7. To determine the Speed of Light in Air and Recreate Foucault's Historical Experiment.
8. To determine the wavelength and velocity of ultrasonic waves in liquid by studying the diffraction of light through an ultrasonic grating.
9. To study resonance with difference frequencies in closed tube, the spatial interference pattern and plotting of output mixed sound waves with a sensor.
10. To study Malus' Law of Polarization and plotting of waves with sensors.

11. To measure a direct voltage, an alternating voltage and the frequency of a sinusoidal voltage using a CRO.

12. To measure the frequency of an AC signal and the phase difference between the two AC voltages using a CRO.

13. To study the Fourier optics filtering and physical principle of optical image addition and subtraction using a diffracting grating.

14. To study how frequency depends on String Tension, string length and string linear density.

15. To determine the frequency of the AC mains using a sonometer

In a semester, approximately 8 experiments from the above list will be selected.

References:

1. Geeta Sanon, B.Sc Practical Physics, R Chand & CO. New Delhi, 5t Edition (2013)
2. B.L.Flint & H.T.Worsnop, Advanced Practical Physics for students, 1971, Asia Publishing House.
3. Michael Nelson and Jon M. Ogborn Advanced level Physics Practicals, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. D.P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, 1985, Vani Publication.
5. H.J.Pain, The Physics of Vibrations and Waves, Wiley India Edition, 6th Edition (2008)
6. Frank S. Crawford Jr., Waves, Berkeley Physics Course- Volume 3, TMH Education Pvt. Ltd, 1st reprint (2011)
7. A.P. French, Vibrations and Waves, CRC press, 1st Edition (2003)
8. N.K. Bajaj, The physics of Waves and Oscillations, TMH, (1998)
9. Ajoy Ghatak, Optics, TMH, (2008)
10. Max Born and Emil Wolf, Principles of Optics, Pergamon Press, 7th Edn., (1999)

Course Expected Outcomes:

Students will be enabled to demonstrate their ability to use the techniques in conducting scientific experiments and observations. Students will be able to assemble components independently to carry out required experiments to achieve results.

SYLLABII FOR SEMESTER - I & SEMESTER-II

CHEMISTRY
CORE COURSES

Paper Code	SEM	SEMESTER AND PAPERS	COURSES AND CREDITS	L	P	C
BSC-101	1	SEM-1	Inorganic Chemistry (Atomic Structure & Chemical Bonding)/Laboratory	2	2	4

Theory

Course Objectives

CO1	The structure of the atom is discussed which is a necessary for understanding the nature of chemical bonding in compounds.
CO2	It provides basic knowledge about ionic and covalent bonding.
CO3	It discusses the periodicity in properties of elements.
CO4	It helps to understand the group chemistry of s and p block.

Unit 1: Atomic Structure

Recapitulation of concept of atom in ancient India, Bohr's theory & its limitations, atomic spectrum of hydrogen atom, de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Quantum numbers and their significance. Shapes of s, p, and d orbitals, Relative energies of orbitals. Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations. **(Lectures: 8)**

Unit 2: Periodic properties of Elements

Brief discussion of the following properties of the elements, with reference to s- & p-block and their trends: (a) Effective nuclear charge, shielding or screening effect and Slater's rules (b) Atomic and ionic radii (c) Ionization enthalpy (Successive ionization enthalpies) (d) Electron gain enthalpy (e) Electronegativity, Pauling's scale of electronegativity. Variation of electronegativity with bond order and hybridization. **(Lectures: 5)**

Unit 3: Ionic Bonding

Ionic Bonding, characteristics of ionic compounds. Lattice energy, Born-Landé equation, importance of Kapustinskii equation for lattice energy. Born-Haber cycle and its applications. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. **(Lectures: 6)**

Unit 4: Covalent and Coordinate bonds

Covalent Bond-Energy changes, potentioal energy curve for H_2 molecule, characteristics of covalent compunds. Co-ordinate bond-Werner's theory, effective atomic number, stability of complexes, isomerism in coordinate cpompunds. Hydrogen Bonding, Van der Walls forces, hybridization and resonance. Valence shell electron pair repulsion theory (VSEPR)- Discussion of structures of H_2O, NH_3, SF_4, ClF_3, PCl_5 etc. Molecular orbital theory, Linear combination of atomic orbitals (LCAO) method, structures of simple homonuclear diatomic molecules like H_2,N_2,O_2,F_2. **(Lectures: 7)**

Course Expected Outcomes

CEO1	By the end of the course, students will be able to understand the structure of the atom which is a necessary for understanding the nature of chemical bonding in compounds.
CEO2	The students will gain the knowledge by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration.
CEO3	The students will gain the basic knowledge about ionic and covalent bonding.
CEO4	The students will gain the knowledge about various theories of coordination compounds.

Reference Books for Theory:

1. Lee, J.D. (2010), **Concise Inorganic Chemistry**, Wiley India.

2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
5. Shiver, D.; Weller, M.; Overton, T.; Rourke, J.; Armstrong, F. (2014), **Inorganic Chemistry**, 6th Edition, Freeman &Company.

Teaching Learning Process:
• Conventional methods of teaching learning e.g. Lectures, use of chalk, blackboard and models. • ICT enabled teaching learning. • Group discussions and quiz.

Assessment Methods:
• Test / Examination • Assignment • Projects based on the real world application of important elements and their compounds • End semester university theory and practical examination.

Keywords:
Atomic structure, ionic bonding, covalent bonding, Valance Bond Theory, VSEPR theory, Molecular Orbital Theory.

Paper Code	SEM	SEMESTER AND PAPERS	COURSES AND CREDITS	L	P	C
BSC-101	1	SEM-1	Inorganic Chemistry (Atomic Structure & Chemical Bonding)/Laboratory	2	2	4

Laboratory

1. Titrimetric Analysis:
(i) Calibration and use of apparatus (ii) Preparation of solutions of titrants of different Molarity/Normality.

2. Acid-Base Titrations:
Principles of acid-base titrations to be discussed. (i) Estimation of sodium carbonate using standardized HCl. (ii) Estimation of carbonate and hydroxide present together in a mixture. (iii) Estimation of carbonate and bicarbonate present together in a mixture. (iv) Estimation of free alkali present in different soaps/detergents.

3. Oxidation-Reduction Titrimetry:
Principles of oxidation-reduction titrations (electrode potentials) to be discussed. (i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution (ii) Estimation of oxalic acid and sodium oxalate in a given mixture. (iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator (diphenylamine, N-phenylanthranilic acid) and discussion of external indicator.

References:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989),Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

Physico-Organic Chemistry

Paper Code	SEM	SEMESTER AND PAPERS	COURSES AND CREDITS	L	P	C
BSC-102	2	SEM-2	Physical Organic Chemistry/Laboratory	2	2	4

Theory

Course Objectives

- **CO1.** To understand properties of ideal and real gases deviation from ideal behaviour
- **CO2.** To understand the basic concepts of organic chemistry like Electronic displacements, Reaction Intermediates, types of reactions etc
- **CO3.** Students are expected to learn the stereochemistry, types of projection formulae, geometrical isomerism etc.

Unit 1 : Gaseous state-I

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, diffusion of gases; **Lectures: 7**

Unit 2: Gaseous state-II

Behaviour of real gases van-der waal equation of state; virial equation of state, critical phenomena; p-V isotherm of CO2, van-der waal equation and critical state, law of corresponding state and liquefaction of gases. **Lectures: 6**

Unit 3: Basic Fundamentals of organic chemistry

Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect. Reaction Intermediates, acids and bases and types of reactions. **Lectures: 6**

Unit 4: **Stereochemistry**

Configurational isomerism: Optical isomerism, concept of chirality (limited to two carbon atoms), enantiomerism, diastereomerism and meso compounds. Types of projection formulae: Newmann, Sawhorse and Fischer representations. R & S configuration. Geometrical isomerism: E/Z configuration. Conformations of ethane, propane and butane. **Lectures: 7**

References/Suggested texts

1. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7th Edition, Pearson Education.
2. Eliel, E. L. (2001), Stereochemistry of Carbon Compounds, Tata McGrawHill.
3. Finar, I. L. Organic Chemistry (Volume 1& 2) 6th edition (2015), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Sykes, P. (2003), A Guide Book to Mechanism in Organic Chemistry, 6th Edition Pearson Education.
5. Bahl, A; Bahl, B. S. (2019), Advanced Organic Chemistry, 22nd Edition, S.Chand.

Course Expected Outcomes:

CEO1	Derive ideal gas law from kinetic theory of gases and explain why the real gases deviate from ideal behaviour.
CEO2	The end of the course the students are able to acquire enough knowledge to understand basics of organic chemistry.
CEO3	This course will help to understand stereochemistry and its importantce towards organic chemistry.

Paper Code	SEM	SEMESTER AND PAPERS	COURSES AND CREDITS	L	P	C
BSC-102	2	SEM-2	Physico Organic Chemistry/Laboratory	2	2	4

LABORATORY

1. To determine the viscosity of the given liquid by Ostwald's viscometer.
2. Estimation of dissolved oxygen in given liquid
3. To determine the refractive index of the given liquid by Abbe refractometer and find the specific and molar refractions
4. To determine the specific and molecular rotation of an optically active compound.
5. Calibration of a thermometer and determination of the melting points of the organic compounds (Kjeldahl method, electrically heated melting point apparatus and BODMEL).
6. Concept of Recrystallisation using alcohol/water/alcohol-water as solvent.
7. Benzolyation of one of the following amines (aniline, o-, m-, p-toluidines and o-, m-,p-anisidine) or one of the following phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
8. Determination of boiling point of liquid compounds.
9. Separation of a mixture of two amino acids/sugars by radial/ascending paper chromatography.
10. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

References:

1. Mann, F.G., Saunders, B.C. (2009), Practical Organic Chemistry, 4th Edition, Pearson Education.
2. Ahluwalia, V.K., Dhingra, S. (2004), Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G.; Tatchell, A.R (2004), Vogel's Textbook of Practical Organic Chemistry, Pearson.
4. Leonard, J., Lygo, B., Procter, G. (2013) Advanced Practical Organic Chemistry, 3rd Edition, CRC Press
5. Senior Practical Physical chemistry by B.D. Khosla, Garg and Gulati, R Chand & Co. , New Delhi ISBN:8180450791
6. Advanced Practical Physical Chemistry by J.B. Yadav, Krishna's Educational Publishers ISBN : 818283

SYLLABII FOR SEMESTER - I & SEMESTER-II

CORE COURSES

MATHEMATICS

Paper Code	SEMESTER	COURSE	L	T	P	C
BSM-101	**SEM 1**	**Calculus**	**2**	**1**	**1**	**4**

CO: Course Objective

CO1	To give exposure to basic concepts related to functions in one variable
CO2	To understand the meaning of the derivative.
CO3	To be able to calculate definite and indefinite integrals

COE: Course Expected Outcomes

COE1	Able to solve tangent and area problems using the concepts of limits, derivatives, and integrals
COE2	Determine derivatives by a variety of techniques
COE3	Demonstrate the connection between area and the definite integral
COE4	Use differentiation and integration to solve real-world problems such as rateof change, optimization, and area problems.

Unit-I Real numbers, Functions, and their graphs. Limits of functions, Left and Right- hand limits. Continuity, Intermediate value property. **Lectures: 10**

Unit-II Differentiation, Chain rule, Implicit differentiation. Extreme values, Rolle's theorem, and Mean value theorems. Local extrema. Limits at infinity, Infinite limits, Asymptotes, Differentials. **Lectures: 10**

Unit-III Definite integrals, Area, Mean value theorem. The fundamental theorem, Indefinite integral. Integration by substitution, Area between curves. Volume by slicing, Volume ofrevolution, cylindricalshells. Lengths of plane curves, Area of surface of revolution. Beta and gamma functions, **Lectures: 10**

Practical Applications based on these units

Text Books:

1. Differential Calculus: Shanti Narayan, S. Chand Publisher
2. Integral Calculus: Shanti Narayan, S. Chand PublisherReference Books
3. Calculus and Analytic Geometry: G. B. Thomas, R. L. Finney, Pearson Education,Asia
4. Advanced Engineering Mathematics: B S Grewal, Khanna Publisher
5. Engineering Mathematics: E. Kreyszig, John Wiley & Sons.
6. Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts inMathematics: Ross, Kenneth. A. Springer. Indian reprint.

Paper Code	SEMESTER	COURSE	L	T	P	C
BSM-102	**SEM 2**	**Linear algebra**	**2**	**1**	**1**	**4**

CO: Course ObjectiveS

CO1 Perform matrix algebra and understand special matrices

CO2 Find eigenvalues and eigenvectors and their applications

CO3 Solve systems of linear equations using various methods

Unit-I **Lectures: 10**

Introduction to matrices, matrix operations, such as the addition of matrices, transpose ofa matrix, scalar multiplication, and matrix multiplication, etc. Types of Matrices. Invertiblematrices, examples, and submatrices of a matrix. Determinant of a matrix,Inverse using theclassical adjoint method. Elementary row operations. Row-reduced echelon form of a matrix and the Rank of a matrix.

Unit-II **Lectures: 10**

System of linear equations, solution set of a linear systemby Gauss elimination and Gauss – Jordan methods, LU decomposition method. Application of the solution set of a linearsystem to linear systems where the coefficient matrix is square, and the Cramer's rule.

Unit-III

Properties and computation of Eigenvalues and Eigenvectors, Cayley - Hamiltontheorem and its applications. Largest and Smallest eigenvalues and eigenvectors by powermethod, Examples and Exercises. **Lectures: 10**

Practical Applications based on these units

Text Books:

1. NUMERICAL LINEAR ALGEBRA, Prof. P. N. Agrawal Prof. D.N. Pandey
2. V. Sundarapandian, Numerical Linear Algebra, PHI, 2008.
3. Biswa Nath Dutta, Numerical Linear Algebra and Applications, SIAM, 2010.
4. Anna Zemlyanova, Appliedprojects for an introductory linear algebra class, https://www.math.ksu.ed

Reference Books:

1.Roger A. Horn and Charles R. Johnson, Matrix Analysis, Cambridge University Press, 1994.
2. William Ford, Numerical Linear Algebra with Applications, Academic Press, 2014.
3..K.Hoffman and R.Kunze, Linear Algebra, 2nd Edition, Prentice- Hall of India, 2005.
4.4.M.Artin,Algebra,Prentice-Hall of India, 2005.

COE: Course Expected Outcomes

COE1	Able to perform common matrix operations
COE2	Define what it means for a linear system to be consistent or inconsistent
COE3	Use eigenspaces of matrices, when possible, to diagonalize a matrix
COE4	Explain the significance of eigenvectors and eigenvalues

INTERDISCIPLINARY COURSES (3 CREDIT COURSES)

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSID101	SEM 1/2/3/4	DISCRETE MATHEMATICS (IDC)	2		1	3
BSID102	SEM 1/2/3/4	COMBINATORICS (IDC)	2		1	3
BSID201	SEM 1/2/3/4	MATHEMATICAL DATA SCIENCE (IDC)	2		1	3
BSID202	SEM 1/2/3/4	NUMBER THEORY (IDC)	2		1	3
BSID301	SEM 1/2/3/4	BIO STATISTICS (IDC)	2		1	3
BSID302	SEM 1/2/3/4	PROGRAMMING IN R (IDC)	2		1	3
BSID401	SEM 1/2/3/4	R-SHINY WEB APP (IDC)	2		1	3
BSID402	SEM 1/2/3/4	COMPUTATIONAL MATHEMATICS (IDC)	2		1	3
BSID501	SEM 1/2/3/4	NONLINEAR DYNAMICS (IDC)	2		1	3
BSID502	SEM 1/2/3/4	WAVELETS (IDC)	2		1	3

CAN BE OUTSOURCED FROM OTHER SCHOOLS AS WELL AS OFFERRED FROM USBAS

SKILL ENHANCEMENT COURSES (3 CREDIT COURSE)

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSSEC101	SEM 1/2/3/4	Excel I (SKILL ENHANCEMENT)	2	0	1	3
BSSEC102	SEM 1/2/3/4	Excel II (SKILL ENHANCEMENT)	2	0	1	3
BSSEC201	SEM 1/2/3/4	LATEX I (SKILL ENHANCEMENT)	2	0	1	3
BSSEC202	SEM 1/2/3/4	LATEX II (SKILL ENHANCEMENT)	2	0	1	3
BSSEC301	SEM 1/2/3/4	SCIENTIFIC WRITING	2	0	1	3
BSSEC302	SEM 1/2/3/4	RESEARCH ETHICS	2	0	1	3
BSSEC401	SEM 1/2/3/4	MAPLE	3	0	0	3
BSSEC402	SEM 1/2/3/4	QUEUING THEORY	3	0	0	3
BSSEC501	SEM 1/2/3/4	FRACTAL GEOMETRY (SEC)	2	0	1	3
BSSEC502	SEM 1/2/3/4	SPACE DYNAMICS (SEC)	2	0	1	3
-	-	COMMUNICATION SKILLS (USHSS)	3	-	-	3
-	-	WRITING SKILLS (USHSS)	3	-	-	3
-	-	ENTREUPRENEAL MINDSET (USMS)	3	-	-	3

- CAN BE OUTSOURCED FROM OTHER SCHOOLS AS WELL AS OFFERRED FROM USBAS

ABILITY ENHANCEMENT COURSES (2 CREDIT COURSE)

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
-	-	CREATIVE WRITING (USHSS)	2	-	-	2
-	-	ENGLISH LANGUAGE I & II (USHSS)	2	-	-	2
-	-	JAPANESE LANGUAGE I & II (USHSS)	2	-	-	2
-	-	GERMAN LANGUAGE I & II (USHSS)	2	-	-	2
-	-	PUNJABI-I & II (USHSS)	2	-	-	2
CAN BE OUTSOURCED FROM OTHER SCHOOLS AS WELL AS OFFERRED FROM USBAS						

VALUE ADDED COURSES-SUGGESTIONS (2 CREDIT COURSE)

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
-	-	ENVIRONMENTAL SCIENCE (USEM)	2	-	-	2
-	-	UNIVERSAL HUMAN VALUES : UNDERSTANDING HARMONY (CENTRE FOR HUMAN VALUES AND ETHICS)	2	-	-	2
CAN BE OUTSOURCED FROM OTHER SCHOOLS AS WELL AS OFFERRED FROM USBAS						

MINOR STREAMS

Any student majoring in Physics/Chemistry and Mathematics can also earn a Minor in an alternate stream, if he/she earns 24-32 credits in 3(4) years from that Minor stream. Minor stream will, have 6 (8) papers of 4 credits each. The following are the courses for the Minor streams initially being offerred

MINOR1- Mathematics

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSMM101	SEM 1	STATISTICS - SEM1	2	1	1	4
BSMM102	SEM 2	PROBABILITY-SEM2	2	1	1	4
BSMM201	SEM 3	NUMERICAL ANALYSIS-SEM3	2	1	1	4
BSMM202	SEM 4	THEORY OF EQUATIONS-SEM4	2	1	1	4
BSMM301	SEM 5	MATHEMATICAL PYTHON (2+1+1)	2	1	1	4
BSMM302	SEM 6	MATLAB PROGRAMMI NG-I (2+1+1)	2	1	1	4
BSMM401	SEM 7	MATLAB PROGRAMMING-II (2+1+1)	2	1	1	4
BSMM402	SEM 8	BIOMATHEMATICS (2+1+1)	2	1	1	4

MINOR2 - QUANTUM INFORMATION

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSQT101	SEM 1	QUANTUM MECHANICS AND QUANTUM TECHNOLOGIES - AN OVERVIEW	4	0	0	4
BSQT102	SEM 2	CLASSICAL INFORMATION THEORY-4 CREDITS	4	0	0	4
BSQT201	SEM 3	QUANTUM MECHANICS AND LINEAR ALGEBRA	4	0	0	4
BSQT202	SEM 4	QUANTUM INFORMATION - I [QUBITS, QUANTUM GATES, CIRCUITS, CRYPTOGRAPHY]	4	0	0	4

MINOR3 - NANOTECHNOLOGY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSNT101	SEM 1	SEM-I: ELEMENTARY MATERIAL SCIENCE	3	-	1	4
BSNT102	SEM 2	SEM-II: CHEMICAL METHODS OF NANOMATERIAL SYNTHESIS 3(T)1(L)	3	-	1	4
BSNT201	SEM 3	SEMESTER-III: STRUCTURE SENSITIVE PROPERTIES OF MATERIALS 3(T)1(L)	3	-	1	4
BSNT202	SEM 4	SEMESTER-IV: SOLUTIONS AND SURFACE PHENOMENON 2(T)2(L)	2	-	2	4
BSNT301	SEM 5	SEM-V: PHYSICAL METHODS FOR PREPARATION OF NANOMATERIALS	2	-	2	4
BSNT302	SEM 6	SEM-VI: CHARACTERIZATION TECHNIQUES OF NANOSTRUCTURED MATERIALS	2	-	2	4
BSNT401	SEM 7	SEM-VII: TRANSPORT IN NANOSTRUCTURES	2	-	2	4
BSNT402	SEM 8	SEM-VIII: COMPUTATIONAL NANOSCIENCE	2	-	2	4

MINOR 4 - BIOCHEMISTRY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSBC101	SEM 1	SEM-I: BIOMOLECULES-I	3	-	1	4
BSBC102	SEM 2	SEM-II: BIOMOLECULES-II	3	-	1	4
BSBC201	SEM 3	SEM-III: PROTEINS AND ENZYMES	3	-	1	4
BSBC202	SEM 4	SEM-IV: BIOENERGETICS	3	-	1	4
BSBC301	SEM 5	SEM-V: HORMONAL BIOCHEMISTRY	3	-	1	4
BSBC302	SEM 6	METABOLISM OF AMINO ACIDS & NUCLEOTIDES	3	-	1	4
BSBC401	SEM 7	METABOLISM OF CARBOHYDRATES AND LIPIDS	3	-	1	4
BSBC402	SEM 8	SEM-VIII: RECOMBINANT DNA TECHNOLOGY	3	-	1	4

MINOR5- POLYMER CHEMISTRY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSPC101	SEM 1	Sem-I: POLYMER CHEMISTRY-I	3	-	1	4
BSPC102	SEM 2	Sem-II: POLYMER CHEMISTRY-II	3	-	1	4

MINOR6- CHEMISTRY

PAPER CODE	SEM	COURSES AND CREDITS	L	T	P	C
BSCM101	SEM 1	STATES OF MATTER AND COLLIGATIVE PROPERTIES	3	0	1	4
BSCM102	SEM 2	ORGANOMETALLICS AND COORDINATION COMPOUNDS	3	0	1	4
BSCM201	SEM 3	CHEMISTRY OF OXYGEN CONTAINING FUNCTIONAL GROUPS AND THEIR APPLICATIONS TO BIOLOGY	3	0	1	4
BSCM202	SEM 4	INTRODUCTION TO THERMODYNAMICS, CHEMICAL KINETICS (IONIC AND CHEMICAL EQUILIBRIA)	3	0	1	4
BSCM301	SEM 5	AROMATIC HYDROCARBONS, HALOARENES, OXYGEN AND NITROGEN	3	0	1	4
BSCM302	SEM 6	QUANTUM CHEMISTRY AND SPECTROSCOPY	3	0	1	4

BSCM401	SEM 7	POLYMER CHEMISTRY	3	0	1	4
BSCM402	SEM 8	MOLECULES OF LIFE	3	0	1	4

The remaining papers of each of the above minor streams will be added in later

SCHEME OF EXAMINATION

All courses will be evaluated in the ratio of 40% (continuous internal evaluation) and 60% (Final end semester examination) - FOLLOWING THE NORMS OF THE UNIVERSITY AS DECIDED FROM TIME TO TIME

SYLLABII FOR SEMESTER - I & SEMESTER-II

MINOR STREAMS

MINOR-1 MATHEMATICS

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSMM101	SEM 1	STATISTICS - SEM1	2	1	1	4

CO: Course Objectives

CO1	To understand methods of summarization of data.
CO2	To understand statistical distributions
CO3	Find definite and indefinite integrals

Unit-I:
Frequency distributions, Discrete and continuous series, Histogram, Frequency polygon, Measure of central tendency, Mean, Median Mode, Measure of dispersion, Range, Quartile deviation, Mean deviation, standard deviation, Relation between measure of dispersion, Coefficients of dispersion, coefficient of variation.

Unit-II:
Skewness and Measure of Skewness, Karl Pearson's coefficients of Skewness, moments, Relation between moments about mean and moments about any other point, Kurtosis, type of Kurtosis, Coefficients of Kurtosis.

Unit-III Correlation and Karl Pearson's coefficients of correlation, Linear Regression, Lines of Regression, coefficients of Regression, Properties of regression coefficients, angle between two lines of regression.

Practical Applications based on these units

Text Books:
1. Modern Mathematical Statistics with Applications. Devore, Jay L., Berk, Kenneth N. & Carlton Matthew A.. Springer.
2. Statistics, Schaum series

Reference Books:

1. Introduction to Mathematical Statistics. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. Pearson. Indian Reprint.
2. Introduction the Theory of Statistics. Mood, A.M., Graybill, F.A., & Boes, D.C. Tata McGraw Hill Pub. Co. Ltd. Reprinted.
3. Mathematical Statistics with Applications. Wackerly, Dennis D., Mendenhall III, William & Scheaffer, Richard L. Cengage Learning.

COE: Course Expected Outcomes

COE1	Able to solve the central tendencies and variation coefficients
COE2	Determine skewness and kurtosis
COE3	Demonstrate the connection between regression and the lines of regression
COE4	Use central tendencies to solve real-world problems such as average, maximum, and optimizations.

MINOR-1 MATHEMATICS

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSMM102	**SEM 2**	**PROBABILITY**	**2**	**1**	**1**	**4**

CO: Course Objective

CO1	To make the students familiar with the basic probability concepts and tools
CO2	To render the students with several examples and exercises that blend their everyday experiences with their scientific interests
CO1	To study situations involving uncertainty or randomness.

Unit-I Sample space and events, Counting Techniques, Interpretations and Axioms of Probability, Unions of Events and Addition Rules, Conditional Probability, Intersections of Events and Multiplication and Total Probability Rules, Independence, Baye's Theorem.

Unit-II Discrete Probability Distributions: Review of Probability, Discrete random variables, Probability mass function, Cumulative distribution function, Expectation and Variance, Moments and Moment Generating function, Characteristic function, Binomial, Poisson, and Geometric distributions - their mean and variance.

Unit-III Continuous Probability Distributions: Probability density function, Cumulative distribution function, Expectation and Variance, Moments and Moment Generating function, Uniform, Normal, and Exponential distributions - their mean and variance.

Practical Applications based on these units

Text Books:

1.Freund's Mathematical Statistics with Applications: I. Miller and M. Miller, Prentice Hall PTR.

2.Probability and Statistics for Engineers and Scientists: R. E. Walpole, R. H.Mayers, S. L. Mayers and K. Ye, Pearson Education

3.Probability and Statistics with Reliability, Queuing and Computer Science Applica- tions: K. S. Trivedi, PHI Learning Pvt. Ltd.

Reference Books:

1.Mood, A. M., Graybill, F. A., Boes, D. C. (1974). Introduction to the Theory of Statistics (3rd ed.). Tata McGraw-Hill Pub. Co. Ltd. Reprinted 2017

2.Probability, Random Variables and Stochastic Processes: A Papoulis & S. U. Pillai, Tata McGraw-Hill.

3.Probability and Statistics: J. L. Devore, Thomson.

4.An Introduction to Probability and Statistics: V. K. Rohatgi and A. K. Md. Ehsanes Saleh, John Wiley and Sons.

COE: Course Expected Outcomes

COE1	Understand some basic concepts and terminology
COE2	Learn about probability density functions and various univariate distributions
COE3	Understand the empiricalfrequencies of so many natural populations, exhibit bell-shaped (i.e., normal) curves, using the Central Limit Theorem.
COE4	Able to apply the real life applications related to distributions and chances for entropy

MINOR 2

QUANTUM INFORMATION

Paper Code	SEMESTER	COURSE	L	P	Total Credit
BSQT101	**SEM-1**	**Quantum Mechanics and Quantum Technologies - an Overview**	**4**	**0**	**4**

CO: Course Objectives

CO1	**The course introduces students to a topical and exciting areas in the frontiers of technology and physics - quantum information and computation, which is expected to revolutionise information technology soon.**
CO2	**Students are exposed to a multidisciplinary area that demands an unusual combination of theoretical computer science and quantum mechanics.**
CO3	**Students are initiated in an area where the government of India has announced a National Mission on Quantum Technologies & Applications (NM-QTA) with a total budget outlay of Rs 8000 Crore for 5 years in 20202, opening up a huge job market in academia and industry in the future.**
CO4	**This course will introduce students to the important concepts of this exciting new field and cover its main ideas, current developments and future trends as a precursor to the rest of the module**

Unit I: A History of Computing: and Computing Technology - introduction and overview - The computer as a physical device - from Charles Babbage to the modern PC, electromechanical & electronic computers, vacuum tubes, & semiconductors, Moore's Law and the future of transistors and computing hardware, The birth of theoretical computer science and the concept of the Universal Turing machine, The Church-Turing Thesis
[12hrs]

Unit II: Classical Information Theory - Landauer and the physical nature of Information, Claude Shannon and the information theory revolution Classical Information Theory, Entropy, data compression, source and channel coding (qualitative) , introduction to Quantum Information Theory

[10 hrs]

Unit III: Quantum Mechanics: a brief history of the birth and development of quantum mechanics - key concepts and principles
[10 hrs]

UniT IV Quantum Technologies: Why quantum information? The shrinking transistor and Moore's law. Hitting quantum scales - the quantum Turing machine, complexity classes, the factorisation problem and the RSA crypto system, Peter Shor's algorithm for factorisation, computing with quantum mechanics, spin offs - quantum cryptography and quantum teleportation, the future of quantum hardware.

[10 hrs]

References/Suggested texts

1. Elements of Information Theory, Thomas M. Cover and Joy A. Thomas (Wiley Series in Telecommunications and Signal Processing) 2006
2. Information Theory: A Tutorial Introduction February 2015, James V. Stone
3. Quantum Computation and Quantum Information, Nielsen and Chuang, (Cambridge Univ. Press 2010)
4. Venugopalan, A. The coming of a classical world. *Resonance* 9, 10–28 (2004). https://doi.org/10.1007/BF02837589

CEO: Course Expected Outcomes

CEO1	Students learn about quantum information, an area expected to revolutionise information technology.
CEO2	Students train in a multidisciplinary area combining computer science & quantum mechanics.
CEO3	Students get a grounding in an area in which National Mission on Quantum Technologies & Applications (20202) has invested Rs 8000 Cr. for 5 years, opening a huge job market in future
CEO4	Students learn the main ideas, current developments and future trends in this area, giving them a definitive edge in future careers in academia and industry

MINOR 2 - QUANTUM INFORMATION

Paper Code	SEMESTER	COURSE	L	P	Total Credit
BSQT101	**SEM-2**	**Classical Information Theory**	**4**	**0**	**4**

CO: Course Objectives

CO1	**The course introduces students to classical information theory**
CO2	**Students are exposed to the ideas of quantifying information and the notions of entropy in information**
CO3	**The course introduces Shannon's mathematical Theory of Communication and the famous source coding and channel coding theorems**
CO4	**This course will introduce students to the important concepts of information theory and cover its main ideas, current developments and future trends.**

Unit I

What is information?- a short history; information and bits; quantifying information; Shannon entropy (or discrete Radom variables); properties of Shannon entropy; Independent Identical Distributions (I.I.D), examples, the Asymptotic Equipartition Property - Shannon's source coding theorem, Data compression and Huffman Coding

[12hrs]

Unit II:

Random variables and probability distributions, Noise and modelling noise, Joint distributions, Mutual Information, Conditional Entropy, Noisy Channel, Shannon's Noisy Channel Theorem

[10 hrs]

Unit III Continuous Random Variables; Entropy of Continuous random variables, Differential entropy, mutual information of continuous variables, correlation, Channel capacity, the Gaussian Channel

[10 hrs]

Unit IV

Physics and Entropy: Disorder**,** Information and thermodynamic entropy, ensembles, Landauer's principle and limit, second law of thermodynamics, Maxwell's Demon, Examples based on UnitsI-IV

[10 hrs]

References/Suggested texts

1. **Elements of Information Theory, Thomas M. Cover and Joy A. Thomas (Wiley Series in Telecommunications and Signal Processing) 2006**
2. **Information Theory: A Tutorial Introduction February 2015, James V. Stone**
3. **Quantum Computation and Quantum Information, Nielsen and Chuang, (Cambridge Univ. Press 2010)**
4. **The Information: A History, A Theory, A Flood - James Gleick Paperback – Vintage; Illustrated edition 6 March 2012**

CEO1	**Students learn the basics of classical information theory**
CEO2	**Students learn the ideas of quantifying information and the notions of entropy in information**
CEO3	**Students are introduced to Shannon's mathematical Theory of Communication and the famous source coding and channel coding theorems**
CEO4	**Students learn important concepts of information theory and its main ideas, current developments and future trends.**

MINOR 3 - NANOTECHNOLOGY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSMM101	**SEM 1**	**ELEMENTARY MATERIAL SCIENCE**	**3**	**-**	**1**	**4**

Course Objectives

CO1	To introduce the students to the class of materials including some engineering materials
CO2	To impart the students knowledge about crystalline solids and their structure determination by XRD
CO3	To make them understand the packing in common solid structures: FCC, HCP and BCC
CO4	To study industrially important non-crystalline materials, ceramics and polymers in detail

Unit-1 – Introduction to Materials 10 Hours

Introduction to materials science, engineering materials, crystalline and amorphous solids, single crystalline and polycrystalline materials. Stable and metastable states, Basic thermodynamic functions, statistical entropy and thermally activated processes.

Unit-2- Structure of Crystalline Materials 10 Hours

Space Lattice and crystal structure, Primitive cell and Seven types of Bravais lattices -Symmetry operations in crystals, Rotational and translational symmetry, Point and Space groups- Indexing of crystal planes- Miller indices, Bragg's diffraction law, Directions and planes in cubic structure, Experimental technique - X-ray diffraction.

Unit-3 Structure & Properties of Solids 8 Hours

Packing of atoms inside solids- packing fraction calculations for FCC, HCP and BCC,
Covalent Solids, Metals and Alloys- tetrahedral and octahedral voids, Ionic Solids- radius ratio rule,
some important silicates

Unit-4 Non-Crystalline Materials –Ceramics &Polymers 10 Hour

Structure and configuration of ceramics- functional properties of advanced ceramics.
Polymers-classification into thermoplastic and thermosetting polymers, addition and condensation polymerization, concept of copolymers & industrial applications of polymers.

Course Expected Outcomes:

By the end of the course, students will be able to have knowledge about:

CO1	Class of materials and dependence of properties on structure of materials
CO2	Crystalline solids, laws governing X-ray crystallography and structure determination by XRD
CO3	Packing factor, density of common cubic crystals
CO4	Temperature behavior of polymers, structure & properties of ceramics

Laboratory:

1. General instruction regarding the cleaning and caliberation of volumetric glassware- volumetric flask, pipettes and burettes
2. Primary and secondary standards- standardization of provided NaOH solution by standard oxalic acid
3. Determination of relative density of the given liquid wrt water
4. Determination of melting point of a pure and amorphous solid
5. To determine iron in an iron ore volumetrically using N-phenylanthranilic acid as internal indicator
6. To determine the amount of Cu in Copper ore solution by titrating against hypo solution
7. To prepare and examine the colours of liquid crystals

Reference Books for Theory

1. Materials Science and Engineering, A First Course by V. Raghavan Sixth edition, Prentice Hall of India ISBN: 9788120350922.

2. Materials Science and Engineering by William F Smith, Javad Hashemi, Ravi Prakash, Fifth edition, McGraw Hill Education (India) Private Limited, ISBN: 9781259062759

Reference Books for Lab

1. Senior Practical Physical chemistry by B.D. Khosla, Garg and Gulati, R Chand & Co. , New Delhi ISBN:8180450791

2. Advanced Practical Physical Chemistry by J.B. Yadav, Krishna's Educational Publishers ISBN : 8182839165

3. Essentials of Experimental Engineering Chemistry by Shashi Chawla, Dhanpat Rai & Co. ISBN: 8177000985

MINOR 3 - NANOTECHNOLOGY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSMM102	**SEM 2**	**SEM-II: CHEMICAL METHODS OF NANOMATERIAL SYNTHESI/LAB**	**3**	**-**	**1**	**4**

Course Objectives

CO_1	To enable students to learn about Chemical precipitation and co-precipitation.
CO_2	To enable students to learn about metal nanoparticles by reduction.
CO_3	To enable students to know the basics of Sol-gel method.
CO_4	To enable students to know the basics of Microemulsions synthesis.

Unit 1: Chemical precipitation and co-precipitation: Fundamentals, Theory and Thermodynamics, Steps involved: Nucleation, Growth, Oswald Ripening and Stabilization. Microwave assisted co-precipitation; Sonochemical assisted co-precipitation.
Unit 2: Synthesis of metal nanoparticles by reduction: Fundamentals, Significance of reduction potentials, Precipitation of Metals by Electrochemical reduction; Precipitation of Metals by Radiation-assisted reduction; Precipitation of Metals by Thermolysis routes.

Unit 3: Sol-Gel Synthesis: Fundamentals, Chemistry of Metal Alkoxides synthesis, Chemistry of Aqueous Metal Cations, Formation of Xerogel and Aerogel, Gel sintering, Control of particle size and morphology, Sol-Gel Synthesis of Metal, oxides and nanocomposites.

Unit 4: Microemulsions: Fundamentals, Formation of Reverse Micelle and Phase Equilibria, Introduction to surfactants, Reaction Dynamics in Reverse Micelles, Synthesis of Metal, oxides and alloys by microemulsion route, Synthesis in supercritical fluids & Solvothermal synthesis.

Course Expected Outcomes:

By the end of the course, students will be able to:

CEO1	The students will get proper knowledge of Chemical precipitation and co-precipitation.
CEO2	The students will learn the fundamentals of metal nanoparticles preparation by reduction and apply these while carrying out a reaction in a laboratory/industry.
CEO3	The students will learn the basics of Sol-gel method.
CEO4	The students will know the basics of Microemulsions synthesis.

Reference Books for Theory

1. Chemistry of Nanomaterials: Synthesis, Properties and Applications - CNR Rao, H.C. mult. Achim Müller, A. K. Cheetham, Wiley−VCH Verlag GmbH & Co. KGaA, ISBN: 9783527306862, 9783527602476, 2004.
2. Nanochemistry: A Chemical Approach to Nanomaterials - Geoffrey A Ozin, André Arsenault, Ludovico Cademartiri, Edition 2, Royal Society of Chemistry, Cambridge UK, ISBN: 978-1-84755-895-4, 978-1-78262-626-8, 2008.
3. Synthesis and Applications of Nanoparticles, A. Thakur, P. Thakur, S.P. Khurana, Springer, Singapore, ISBN: 978-981-16-6818-0, 978-981-16-6821-02022.
4. Introduction to Nanotechnology - R. Singh, S. M. Gupta, Oxford University Press, ISBN:9780199456789, 2016.

MINOR 4 - BIOCHEMISTRY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSBC101	SEM 1	BIOMOLECULES-I/Lab	3	-	1	4

Course Objectives:

CO1. To provide an advanced understanding of the core principles and topics of biochemistry, their experimental basis and enable students to acquire a specialised knowledge & understanding of structure and functions of biomolecules like; amino acids and Carbohydrates.

CO2 To provide understanding of characterisation, separation and significance of biomolecules like:; amino acids and Carbohydrates.

CO3 To provide hands on approach and learnings of different laboratory techniques to analyse amino acids and carbohydrates in the biochemical laboratory.

Lectures: 10

Unit-1: Biomolecules: Definition, general introduction of composition of living matter, Cell wall structure and function with reference to gram positive and gram negative bacteria.

Lectures: 15

Unit-2: Amino acids: Introduction to amino acids with respect to structure, classification, Essential and Non-Essential amino acids, classification on the basis of R group. Proteinaceous and non-proteinaceous amino acids, Physical and chemical properties of amino acids. Separation and characterisation and significance of amino acids. Introduction of peptides like Glutathione, Oxytocin, Insulin.

Lectures: 20

Unit-3: Carbohydrate: Definition, structure and function of Monosaccharides, oligosaccharides and polysaccharides, their inter relationship. Important derivatives of Monosaccharides, oligosaccharides and polysaccharides (Glucose, fructose, maltose, lactose, cellobiose, Sucrose, Trehalose, Rabinose, Rhamnose, Raffinose, starch, glycogen, Cellulose, chitin, pectins, hyaluronic acid, chondroitin sulphate-A & C, Agar-agar, Heparin).

Suggested Textbooks
1. Nelson, D.L. and Cox, M.M.(2009). Lehninger`s Principles of Biochemistry, W.H.
Freeman and Co, New York.
2. Biochemistry by Lubert Stryer. 4th Edition. 1995. **Publisher:** W H Freeman & Co, New York

Biomolecules-1 Practicals

1. Preparation of normal, molar, molal and percent solutions.
2. Preparation of buffer solutions.
3. Titration curve of Glycine.
4. Qualitative tests for Carbohydrates, Amino acids, Proteins,
5. Preparation of casein from milk and determination of its isoelectric point.

Course Expected Outcomes: at the end of the course students will be able to

CEO1 Understand the structural and functional relationships of biological molecules that form the basis of living organisms

CEO2 Understand how biomolecules are isolated and characterised through various analytical techniques that are used in contemporary biochemistry laboratories.

CEO3 Have better practical understanding of methods/techniques covered in theory course.

MINOR 4 BIOCHEMISTRY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSBC102	**SEM 2**	**BIOMOLECULES-II/Lab**	**3**	**-**	**1**	**4**

Course Educational Objectives:

1. To provide an advanced understanding of the core principles and topics of biochemistry, their experimental basis and enable students to acquire a specialised knowledge & understanding of structure and functions of Lipids, nucleic acids and vitamins
2. To provide understanding of characterisation, separation and clinical significance of Lipids, nucleic acids and vitamins.
3. To provide hands on approach and learnings of different laboratory techniques to analyse Lipids, nucleic acids and vitamins in the biochemical laboratory.

Unit-1: Lipids: Definition and classification of lipids. Structure and function of lipids: fatty acids, glycerol, sphingosine. physio-chemical properties of fatty acids, separation of fatty acids, distribution of fatty acids in nature and characterization of fatty acids, acid, saponification and iodine value. Properties of glycerol, fats and oils. Systematic nomenclature and classes of glycerides, MAG, DAG, TG, phospholipids, PA, PG, PE, PS, LPC, PI and plasmalogens, sphingolipids - sphingosine, ceramide, sphingomyelin, glycolipids cerebrosides, gangliosides and sialic acids. Properties and function of phospholipids and Prostaglandins.
Isoprenoids- types and structures, structure of sterols, Bile acids, steroid hormones, plant sterol, ergosterol, stigma sterol, cholesterol, glucocorticoid, mineralocorticoids.
Lipoproteins - classification, composition and their importance, Role of Lipids in cellular architecture and functions. Clinical implication of lipids.

[20]

Unit-2: Nucleic acids: General structure and composition of nucleic acids, the purine and pyrimidine bases, Tautomeric forms of bases. Reactions of purines and pyrimidines, structure of nucleosides and nucleotide, deoxynucleotides, cyclic nucleotides and polynucleotides. Watson and crick model for DNA. Different types of DNA and RNA. Replication of DNA. Importance of nucleic acids in living system.

[15]

Unit-3: Vitamins: Structure, function, sources and deficiency disorders of fat soluble vitamins A, D, E & K. Water soluble vitamins, their co- enzyme forms and deficiency disorders, Thiamine, riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid and ascorbic acid.

[10]

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M.(2009). Lehninger`s Principles of Biochemistry, W.H. Freeman and Co, New York.
2. Biochemistry by Lubert Stryer. 4th Edition. 1995. **Publisher:** W H Freeman & Co, New York

Biomolecules-2 Practical

1. Qualitative tests for Lipids and nucleic acids.
2. Determination of Acid value
3. Determination of iodine value
4. Determination of saponification value
5. Titrimetric analysis of Vitamin C.

Course Outcomes: at the end of the course students will be able to:

(1) Understand the structural and functional relationships of biological molecules that form the basis of living organisms.

(2) Understand how biomolecules are isolated and characterised through various analytical techniques that are used in contemporary biochemistry laboratories.

(3) Have better practical understanding of methods/techniques covered in theory course.

MINOR 5

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSPC101	SEM 1	Sem-I: POLYMER CHEMISTRY-I	3	-	1	4

COURSE OBJECTIVES

1. To discuss the general chemistry of polymers,

2. To familiarise the students with the different term related to polymer, types of polymers,

preparation and significance of polymers

3. To understand in detail the mechanisms of the polymer reactions.

Unit 1- Historical development of polymer chemistry. Definitions of monomers, polymers,repeating units, functionality. Nomenclature of polymers. Importance and applications of polymers, acrylic, vinyl, cellulose, fluorinated, poly ethylene, & SAN copolymer. Classification of polymers. Ladder and spiral polymers. Cis- trans configuration. DL isomers and tactility.

Unit 2–Inorganic polymers- importance, advantages and applications- structure, preparation and properties of silicones and polyphosphazenes. Comparison with organic polymers. Chain growth polymerisation. Mechanism of chain growth polymerisation. Initiation, propagation and

termination.

Unit 3-Types of free radical initiators (peroxo, azo and redox initiators).Initiator efficiency.Inhibitors and retarders – functions and examples. Chain transfer reactions. Kinetics of chaingrowth polymerisation. Kinetic chain length. Auto acceleration, thermal & electrochemical polymerisation.

POLYMER CHEMISTRY-1 Practicals

Practicals will be based on theory contents

1. Determination of Glass Transition Temperature, Tg: Dilatometry Techniuque

2. Removal of inhibitor from monomer by washing with alkali and determination of purity by refractive index measurement.

3. Preparation of polystyrene (or PMMA)

4. Synthesis of vinyl ester resin and determination of acid number.

5. Preparation of Urea-Formaldehyde Resin

6 Preparation of Phenol-Formaldehyde Resin

Course Outcomes: at the end of the course students will be able to:

(1) Understand the general chemical aspect of polymers.

(2) Understand different term related to polymer, types of polymers, preparation and significance

MINOR 5 POLYMER CHEMISTRY

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSPC102	SEM 2	Sem-II: POLYMER CHEMISTRY-II	3	-	1	4

Course Objectives

CO1	To develop basic and advance concepts regarding conformation of polymers
CO2	To understand the crystallinity and its effect on properties on physical properties
CO3	To derive the expressions for determining the physical properties of polymer/ polymer solution, and study various factors affecting the properties
CO4	To study the concept of average molecular weight of polymers and the determination of molecular weight by different methods

1. Introduction and history of polymeric material, classification of polymers, configuration and confirmation of polymers. Nature of molecular interaction in polymers, cumulative interaction, entanglement, random chain model and rms end-to-end distance. Various structures of copolymers such as linear, branched and cross-linked copolymers and their types.

2. Crystal Morphologies: extended chain crystals, chain folding, lamellae and spherulites. Crystallization and crystallinity, determination of melting point and degree of crystallinity.

3. Properties of polymers (physical, thermal, flow and mechanical properties).

4. Glass transition temperature T_g and measurement of T_g. Factors affecting the glass transition temperature. WLF equation.

5. Polymer solution - solubility parameter, properties of dilute solutions.

6. Nature and structure of polymers-structure-property relationships. Molecular weight of polymers (Mn, Mw etc.), molecular weight distribution and determination of molecular weight.

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Course Expected Outcomes:

By the end of the course, students will be able to:

CEO1	Derive expressions relating properties of gas and will be able to appreciate the affect of functional groups on the solubility of the polymer.
CEO2	Understand the physical significance of glass transition temperature
CEO3	Explain the physical properties of the polymers.
CEO4	Explain the concept molecular weight distribution, polydispersity and its effect on the physical properties

Polymer Chemistry – II (Practical):

1. Separation and purification of polymer.

2. Chemical Identification of polymers

3. To Identify polyolefins by density method

4. To Determine the melting point of crystalline polymers

5. Determination of number average molecular weight of polymers by end group analysis

6. Determination of viscosity average molecular weight of polymers by solution viscosity method

7. To check the solubility of polymers in different solvents

Suggested Readings.

1. Plastics Materials by. J.A. Brydson, Butterworth, Heinemann (1999).
2. Polymer Science and Technology of Plastic and Rubber by P. Ghosh, Tata McGraw Hill.(1990).
3. Polymer Science by Gowarikar V.R. New Age International Publishers Limited,(1986).
4. Molecular weight distribution in polymer by LH Pebbles. Wiley Interscience N.Y.(1971)
5. Textbook of Polymer Science by Fred W. Billmeyer, Wiley, India (2007)
6. Polymer crystallization by Schultz, American chemical Society (2001)
7. Polymer Chemistry by.Seymour R.B. and Carraher, Marcel Decker (2000).

MINOR 6 CHEMISTRY

PAPER CODE	SEM	COURSES AND CREDITS	L	T	P	C
BSCM101	SEM 1	STATES OF MATTER AND COLLIGATIVE PROPERTIES	3	0	1	4

Course Objectives

CO1	To develop basic and advance concepts regarding the three states of matter.
CO2	To understand the behavior of ideal and real gases.
CO3	To derive the expressions for determining the physical properties of liquids and solids.
CO4	To study the concept of Colligative properties and apply them for the determination of molar mass of unknown solute.

Unit 1 :Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. Equation of states for real gases; van der Waals equation of state, its derivation and application in explaining real gas behaviour, Virial coefficients, calculation of Boyle obhnjmmuu

Unit 2: Liquid state: Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapor pressure, surface tension and coefficient of viscosity, and their determination.

Unit 3: Solid state: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices,seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method.

Unit 4: Dilute solutions; lowering of vapour pressure, Raoult's law, Henry's law. Elevation of Boiling Point, Depression of Freezing point and Osmotic pressure and derivation of expressions for these using chemical potential. Application of colligative properties in calculating molar masses of normal, dissociated and associated solutes in solutions. Concept of activity and activity coefficients.

Course Expected Outcomes:

By the end of the course, students will be able to:

CEO1	Derive expressions relating properties of gas and will be able to appreciate the affect of functional groups on the solubility of the polymer.
CEO3	Explain the physical properties of the polymers.
CEO4	Explain the concept molecular weight distribution, polydispersity and its effect on the physical properties

Reference Books for Theory

1. Peter Atkins (Author), Julio De Paula (Author) Physical Chemistry: Tenth Edition (Old Edition) (2014)

2. Puri, B., Sharma, L., & Puri, B. Principles of Physical Chemistry (Vishal Publishing co.)

3. 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.3, 3rd Edition, Macmillan Publishers India limited.

MINOR 6 CHEMISTRY

PAPER CODE	SEM	COURSES AND CREDITS	L	T	P	C
BSCM102	SEM 2	ORGANOMETALLICS AND COORDINATION COMPOUNDS	3	0	1	4

Total Lectures: Theory- 30, Practical-60

Objectives:

The purpose of the course is to introduce students to some important d-block metals and their compounds which they are likely to come across. Students learn about organometallic compounds, a frontier area of chemistry providing an interface between organic and inorganic chemistry. It familiarizes them with coordination compounds which find manifold applications in diverse fields.

Learning Outcomes:

By the end of the course, the students will be able to:

- Familiarize with different types of organometallic compounds, their structures and bonding involved.
- Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
- Identify important structural features of tetrameric methyl lithium and understand the concept of multicenter bonding in these compounds
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
- Use IR data to explain the extent of back bonding in carbonyl complexes

- Understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes
- Understand the properties of coordination compounds and VBT and CFT for bonding in coordination compounds
- Explain the meaning of the terms Δ_O, Δt, pairing energy, CFSE, high spin and low spin
- CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy

Unit 1: Organometallic Compounds Lectures: 12

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structure and bonding of methyl lithium and Zeise's salt. Structure and physical properties of ferrocene. 18-electron rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Unit 2: Coordination Chemistry Lectures: 04

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands.

Unit 3: Lectures: 14

Bonding in coordination compounds

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes of Cr, Fe, Co and Ni. Drawbacks of VBT.

Crystal Field Theory

Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields. Crystal field stabilization energy (CFSE), concept of pairing energy. Factors affecting the magnitude of Δ_O.

Spectrochemical series. Splitting of d orbitals in tetrahedral symmetry. Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry. Jahn-Teller distortion, square planar coordination.

Practicals: Credits: 01

1. Gravimetry

Discuss basic principles of gravimetry (precipitation, co- precipitation and post precipitation, digestion, washing etc)

(i) Estimation of Ni(II) using dimethylglyoxime (DMG). (ii) Estimation of copper as CuSCN.

(iii) Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

2. Inorganic Preparations

(i) Schiff's base involving ethylenediamine and salicylaldehyde (or any other amine and aldehyde/ketone) and to check its purity using TLC.

(ii) Nickel/ Copper complex of the above prepared Schiff's base and its characterisation using UV/Vis spectrophotometer. The IR spectra also to be interpreted (iii) tetraamminecopper (II) sulphate
(iv) potassium trioxalatoferrate (III) trihydrate.
(v) tetraamminecarbonatocobalt(III) nitrate

References:

Theory:

¥ Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, W. H. Freeman and Company.

¥ Miessler, G. L.; Fischer P.J.; Tarr, D.A. (2014), **Inorganic Chemistry**, Pearson.

¥ Huheey, J.E.; Keiter, E.A., Keiter; R.L., Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.

¥ Pfennig, B. W. (2015), **Principles of Inorganic Chemistry.** John Wiley & Sons.

¥ Cotton, F.A.; Wilkinson, G. (1999), **Advanced Inorganic Chemistry** Wiley-VCH.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

2. Schiff Base Complex of Cu (II) with Antibacterial and Electrochemical Study, Arjun C. Bhowmick , Majharul I. Moim, Miththira Balasingam **, American Journal of Chemistry** 2020, 10(2): 33-37, DOI: 10.5923/j.chemistry.20201002.03

Teaching Learning Process:

¥ Conventional chalk and board teaching,

¥ Class interactions and discussions

¥ Power point presentation on important topics.

Assessment Methods:

¥ Presentations by Individual Student/ Group of Students

¥ Class Tests at Periodic Intervals.

¥ Written assignment(s)

¥ End semester University Theory and Practical Examination

Keywords: Organometallic compounds, metal carbonyls, synergistic effect, Coordination compounds, VBT, Crystal field theory, Splitting of d levels, Dq

INTERDISCIPLINARY COURSE (IDC)

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSID101	SEM 1	DISCRETE MATHEMATICS (IDC)	2		1	3

CO: Course Objective

CO1	To understand Order (or partial order) and related properties.
CO2	To understand notion of a lattice which is also a step towards abstract algebra
CO3	Concept of Boolean algebra and its applications to minimizing a Boolean polynomial and switching circuits, which has further applications in computerscience

Unit-I Sets, Relations and Functions : Sets, Propositions and logical operations, Conditional statements, Mathematical induction, Relations and equivalence relation, Equivalence classes, Partial order relation, Partially ordered set, Hasse diagrams, Chain, Maximal and minimalelements, least and greatest elements, Least upper bound, Greatest lower bound, Zorn's lemma, Functions and bijective functions, Functions between POSETS, Order iso- morphism.

Unit-II Lattices : Lattice as a POSET, Lattice as an algebra and their equivalence, Boundedlattices, Sublattices, Interval in a lattice, Products and homomorphism of lattices, Isomorphism of lattices; Distributive, Complemented, Partition and pentagonallattices.

Unit-III Boolean Algebra and Switching Circuits : Boolean algebra, De Morgan's laws, Boolean expressions, Truth tables, Logic diagrams, Boolean functions, Disjunctive normalforms (as join of meets), Minimal forms of Boolean polynomials, Quine Mc-Cluskey method,Karnaugh maps, Switching circuits, Applications of switching circuits.

COE: Course Expected Outcomes

COE1	Understand the basic concepts of sets, relations, functions, and induction.
COE2	Understand mathematical logic and logical operations to various fields.
COE3	Understand the notion of order and maps between partially ordered sets.
COE4	Minimize a Boolean polynomial and apply Boolean algebratechniques to decode switching circuits

Text Books:

1. Discrete Mathematical Structures. Bernard Kolman, Robert C. Busby, & Sharon CutlerRoss. Pearson education Inc., Indian reprint.
2. Discrete Mathematics and its applications with combinatorics and Graph Theory. Rosen,Kenneth H.. McGraw Hill Education.
3. Fundamentals of Discrete Mathematics, R S Salaria, Khanna Publishers

Reference Books:

1. Applied Abstract Algebra. Undergraduate text in Mathematics, Rudolf Lidl, & GunterPilz. Springer (SIE), Indian Reprint.

INTER DISCIPLINARY COURS (IDC)

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSID102	SEM 2	COMBINATORICS (IDC)	2		1	3

CO: Course Objective

CO1	**To understand various techniques of permutations.**
CO2	**To understand combinations, and inclusion-exclusion**
CO3	**Learn basic models of generating functions and recurrence relations in theirapplication to the theory of integer partitions.**

UNIT – I: Basics of Combinatorics: Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial coefficients, Multinomial coefficients, Counting subsets of size k; Set-partitions, The inclusion-exclusion principle and applications.

UNIT – II: Generating Functions and Recurrence Relations: Generating functions: Generating function models, calculating coefficients of generating functions, Polynomial expansions, Binomial identity, Exponential generating functions. Recurrencerelations: Recurrence relationmodels, Divide- and-conquer relations, Solution of linear recurrence relations, Solutions by generating functions.

UNIT – III: Partition: Partition theory of integers: Ordered partition, Unordered partition, Ferrers diagram, Conjugate of partition, Self-conjugate partition, Durfee square, Euler's pentagonal theorem.

Text Books:

1. Combinatorial Techniques. Sane, Sharad S. Hindustan Book Agency (India).
2. Applied Combinatorics. Tucker, Alan. John Wiley & Sons, Inc.Reference Books:
3. Introductory Combinatorics (5th ed.). Brualdi, Richard A. Pearson Education.

4. Combinatorics: Topics, Techniques, Algorithms. Cameron, Peter J. Cambridge University Press. BSM-107 Course Objecti

COE: Course Expected Outcomes

COE1	Understand the basic concepts of induction.
COE2	Enhance the mathematical logical skills by learning different enumerationtechniques.
COE3	Understand the techniques in solving problems in other area of mathematics
COE4	To provide reasoning and arguments to justify conclusions

SKILL ENHANCEMENT COURSE

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSSEC101	SEM 1	Excel I (SKILL ENHANCEMENT)	2	0	1	3

Unit I:
Workbook and worksheets- Navigation with keyboard, Tabs and ribbons, file menu, quick access toolbar,create print and save workbook, worksheet basics, protecting excel workbook and worksheet, importing and exporting data, co-authoring; Data and Formatting-Adding Data, Cut Copy Paste , Data fill ,Data Movement , Cell Formatting ,Conditional Formatting, Cell Operations, Reusable Lists , Data Validation , Sorting And Filtering , Tables. Saving and updating workbooks, Insert and remove hyperlinks, The Sparkline, The Trendline

Unit II:
Understanding formulas; operators in formula; named ranges; calculations; functions in formulas; relativeand absolute addressing; referencing cells outside the worksheet and workbook; functions - logical, summarizing, text , lookup, reference, data and time, math functions; error handling, formula auditing.

Unit III: Charts types and uses, Chart depiction – column, line, pie, bar, bubble, histogram Analysis - Pivot Table,Pivot Charts, Create and email worksheet, preparing to print, Page Setup options, Printing worksheets

Text Books:

1. Manisha Nigam, “Data Analysis with Excel”, BPP publications
2. Microsoft Excel 2019 Data Analysis and Business Modeling Skills), 6th Edition, by Wayne Winston

Reference:

1.Excel 2019 Bible, 1°' Edition, by Michael Alexander Richard Kusleika, Walkcnbach

COE1	To understand the use of Workbook and worksheet
COE2	Ability to apply formulas in workbook and worksheet
COE3	Able to use various types of Charts

COE4	To understand the real life applications in spreadsheets

2.

SKILL ENHANCEMENT COURSE

Paper Code	SEM	COURSES AND CREDITS	L	T	P	C
BSSEC102	SEM 2	Excel II	2	0	1	3

CO: Course Objectives

CO1	Introduction to functions
CO2	Introduction to concepts in workbook and worksheet
CO3	Introduction to various types of spreadsheets

Unit I:

Manage Workbook Options and Settings, Create Tables, Perform Operations with Formulas and Functions (Basic functions, Mathematical functions, Date and Time functions), Formatting and Proofing, Sorting and Filtering(Multiple-level sorting, Custom sorting, AutoFilter), Protecting Excel,

Unit II:

Understanding functions; SUM function, MIN and MAX functions, COUNT function, AVERAGE function, Rules to enter a function, Conditional Operations by using Functions, logical operations by using the IF function, logical operations by using the SUMIF function, logical operations by using the AVERAGE IF function, Insert text boxes, shapes, images in an excel worksheet

Unit III:

What If Analysis (Goal Seek, Data Tables, Scenario Manager), Apply Custom Data Formats and Layouts,Create Advanced functions and Formulas (Logical Functions, Lookup functions, Reference functions, Power Functions), Data validation (Inbuilt and custom validation), Working with Templates, Create Advanced Charts and Tables, Using VBA Macro, New Features of Excel

Text Books:

1.Manisha Nigam, "Data Analysis with Excel", BPP publications
2.Microsoft Excel 2019 Data Analysis and Business Modeling Skills), 6th Edition, by Wayne Winston
3.littps://www.corporatefinanceinstitute.com

Reference:

1. Excel 2019 Bible, 1° Edition, by Michael Alexander Richard Kusleika, Walkcnbach.

COE: Course Expected Outcomes

COE1	To understand the use of functions
COE2	Ability to apply concepts in workbook and worksheet
COE3	Able to use various types of applications
COE1	To understand the real life applications in spreadsheets