SANJAY GHODAWAT UNIVERSITY KOLHAPUR

Sanjay Ghodawat University (SGU) is established in the Academic Year 2017-18, as a State Private University under Govt. of Maharashtra Act No. XL of 2017 dated 3rd May 2017, with the approval of the UGC and the state Government. "For the true measure of giving is giving without measure." Spread across 150 Acres, Sou. Sushila Danchand Ghodawat Charitable Trust's Sanjay Ghodawat University (SGU) is situated in serene atmosphere amidst idyllic hills and lush green meadows to study in harmony with Nature. The Institution aspires to run along the lines of best-in- the-world education and become a world-class institution where teaching-learning process gets a far deeper meaning. SGU always stands as the guiding star of brilliance, quality and deliverance beyond expectations. Innovativeness and Creativity are the hallmarks of a genius enterprise and SGU stands to be a stage where these qualities would be nurtured, encouraged and blossomed. The genius is incomplete without the sense of social responsibility and SGU's ultimate goal remains the development of an attitude of gratitude that freely gives back without expectations.

The Sanjay Ghodawat University stands as a beacon of light to guide the younger generation of the day on the right path to fulfillment in career and life. The USP of the University is its research based curriculum and academically oriented teaching staff. The world class ambience and infrastructure helps the students to easily accommodate themselves in an environment that is conducive to the teaching- learning process. Hands on experience, challenge based case studies, maximum participation of students in the classroom, use of modern digital technology, smart classrooms, solution oriented thinking promotion, stress on research and innovation, international tie ups, choice based credit system for flexibility in choosing areas of interest etc. are some of the features of the University.

The university will help students develop as a unique individual-to be educated as a whole person, intellectually, emotionally, socially, ethically, and spiritually. The educational program designs are worked out meticulously in line with best in class universities with special focus on:

- Flexible Choice Based Credit System
- OBE - Outcome Based Education System
- Experiential Learning
- Project Based Learning
- Case Based Learning
- Training need analysis based on Performance Appraisal System

- Active Learning tools for effective delivery
- Mentoring / Proctorship
- On line learning /Self learning platforms
- Flipped Classroom concept
- Effective Student Feedback Mechanism

VISION

Internationally recognized university of excellence in creating and disseminating knowledge through value-based quality education leading to betterment of mankind.

MISSION

- To prepare students for life-long learning and leadership in a global academic culture
- To create intellectual manpower relevant to the industry and society at large
- To collaborate with institutions of international repute for academic excellence
- To promote research and development through conducive environment
- To encourage entrepreneurship and skill development programs

CORE VALUES

- Integrity
- Transparency
- Accountability
- Equality
- Empathy
- Stewardship

QUALITY POLICY

Sanjay Ghodawat University is committed to establish high standards in value-based quality education to enhance and nurture young minds to excel in their chosen profession and develop into socially responsible citizens through resourceful collaboration, innovation and research

About School of Science

Since inception of Sanjay Ghodawat Institute in 2009, now Sanjay Ghodawat University has made constant efforts to provide quality education and a platform for development of students. School of Science currently offers BSc, MSc and PhD programs in but not limited to Physics, Chemistry and Mathematics. These programs have right blend of academia, research and industry providing an excellent opportunity for students to learn and flourish their career. Because of collaborations of School of Science with institutes, research laboratories and industries, students get number of opportunities of live projects, internships and placements. Our programs aim to provide skill based theoretical, practical and scientific knowledge to students. Our courses are focused towards development of following skills of students. Our courses are focused towards development of following skills of students.

Intellectual skills:

1. Ability to demonstrate understanding of a broad set of knowledge concerning the fundamentals in the basic areas of the discipline.
2. Ability to apply their knowledge to design, carries out, record and analyze the results of experiments.
3. Skills to communicate the results of their work.

Practical skills:

1. Skills in the monitoring of properties by observation and measurement, and the systematic and reliable recording and documentation.
2. Skills in the operation of standard instrumentation.
3. Skills required for the conduct of documented laboratory procedures involved.

Transferable skills:

1. Skills of both oral and written communication.
2. Problem solving skills.
3. Mathematical skills, correct use of units and data presentation.
4. Information retrieval skills.
5. IT skills.
6. Interpersonal skills such as interaction with others and team work.
7. Time management and organizational skills.
8. Skills related to ethical, social and professional understanding.

About Department of Physics

The Department of Physics is established in Academic Year 2017-18 under School of Science in the Sanjay Ghodawat University, Kolhapur. The department runs three courses under graduate, post graduate and Ph.D. The department consists of well-equipped laboratories and well qualified faculty members to handle the UG as well as PG courses. The department aims at developing the practical approach through skill enhancement courses, certifications course and project oriented learning. The research attitude is developed among students through research inclined courses and projects. The continuous development of quality research areas and exposure to research at reputed Institutes or Universities through internship would help in developing the careers of the next generation Physicists.

About Department of Chemistry

Chemistry is central science that deals with everyday life. Chemistry is all about knowing, measuring and making material. It can be making molecules, modifying and studying their properties. Department of Chemistry, Sanjay Ghodawat University aims to become world class teaching and Research Centre. Students can make their bright career in chemistry with our graduate, post graduate and PhD programs in chemistry. Deep understanding of chemistry can enable our graduates to take up new challenges in all aspects of chemistry that includes organic synthesis, chemical analysis, catalysis, nanotechnology, biochemistry etc. Our focused skill enhancement courses develop intellectual, practical and transferable skills of students.

About Department of Mathematics

The Department of Mathematics in Sanjay Ghodawat University was established in the year 2017. The Department offers Bachelor of Science (B.Sc.) and Master of Science (M.Sc.) in Mathematics with the major objective of developing a center of excellence especially in Mathematical Sciences and Applications.

The department offers opportunities for the education and research in a wide range of areas in Mathematics such as: Algebra and Analysis, Differential Equations and their applications, Discrete Mathematics and applications, Operations Research and Mathematical Software's etc.

The department has qualified and well experienced faculty members. Also the department has a computer lab where students can develop their programming skills by practicing in various software's viz. MATLAB, Sage, WxMaxima, C/C++, GAP, GeoGebra, LaTex etc. The department of Mathematics aims to prepare students who are oriented towards research and teaching in both fundamental and advanced areas of Mathematical Sciences.

CHOICE BASED CREDIT SYSTEM (CBCS)

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.

University Grants Commission has come up with the Choice Based Credit System (CBCS) programme in which the students have a choice to choose from the prescribed courses, which are referred as core, elective or minor or soft skill courses and they can learn at their own pace and the entire assessment is graded-based on a credit system. The basic idea is to look into the needs of the students so as to keep up-to-date with development of higher education in India and abroad. CBCS aims to redefine the curriculum keeping pace with the liberalization and globalization in education. CBCS allows students an easy mode of mobility to various educational institutions spread across the world along with the facility of transfer of credits earned by students.

Where the students can choose the prescribed courses, as the core, and elective or soft skill courses, from a range of options, rather than to simply consume what the curriculum offers. They can learn at their own pace and the assessments are graded based on a credit system. It provides an opportunity for students to have a choice of courses or subjects within a programmed resembling a buffet, against the mostly fixed set of subjects now being offered (except for the limited choice of electives in professional degrees and postgraduate programmers) with the flexibility to complete the programmed by earning the required number of credits at a pace decided by the students.

The UGC has always initiated measures to bring efficiency and excellence in the Higher Education System of India. The basic motive is to expand academic quality in all aspects, right from the curriculum to the learning-teaching process to examination and evaluation systems. However, so far multiple methods are followed by different universities across the country towards examination, evaluation and grading system. Considering this diversity, the implementation of the choice based credit system seems to be a good system in assessing the overall performance of a student in a universal way of a single grading system.

OUTCOME BASED EDUCATION (OBE) MODEL

Sanjay Ghodawat University (SGU) has implemented OBE model of education, which is a learner centered approach. SGU has witnessed a sea change in the entire academic systems with implementation of all three components of OBE – Design, Delivery and Assessment. The SGU model of autonomy focuses on experiential learning which believes in learning by doing. This is achieved through hands on experience, industrial assignments, mini projects and live problem solving and collaboration with industries.

SGU is set in to dynamics of transformation and witnessing a shift in focus from teaching to learning and entire academic system of SGU is designed to provide multiple learning opportunities for students to acquire and demonstrate the Knowledge, Skills and Attitudes (KSA) for rewarding career.

The Vision and Mission of the Management, contribution from eminent BOG members and knowledgeable members of Academic Council and Board of Studies, the motivation and drive of the Director, the relentless efforts of the fellow Deans and Head of Departments and all teaching and non-teaching staff along with commitment to learning of students made it possible to successfully transform the institute and stand out to carve a niche for itself as an Institute of repute.

OBE is an approach of curriculum design and teaching that focuses on what students should be able to do (attained) at the end of course/ program. Outcome based education (OBE) is student-centered instruction model that focuses on measuring student performance through outcomes. Outcomes include knowledge, skills and attitudes (KSA). Its focus remains on evaluation of outcomes of the program by stating the knowledge, skill and behavior a graduate is expected to attain upon completion of a program and after 4 – 5 years of graduation. In the OBE model, the required knowledge and skill sets for a particular degree is predetermined and the students are evaluated for all the required parameters (Outcomes) during the course of the program.

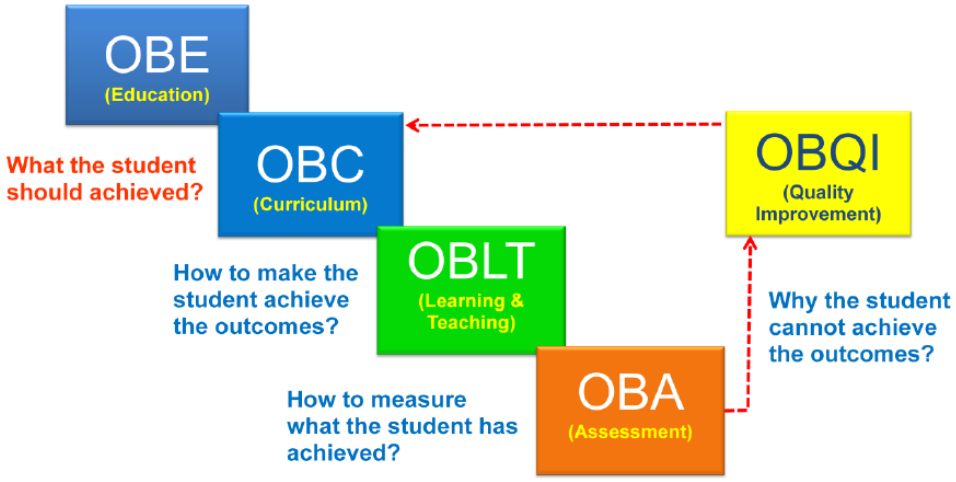
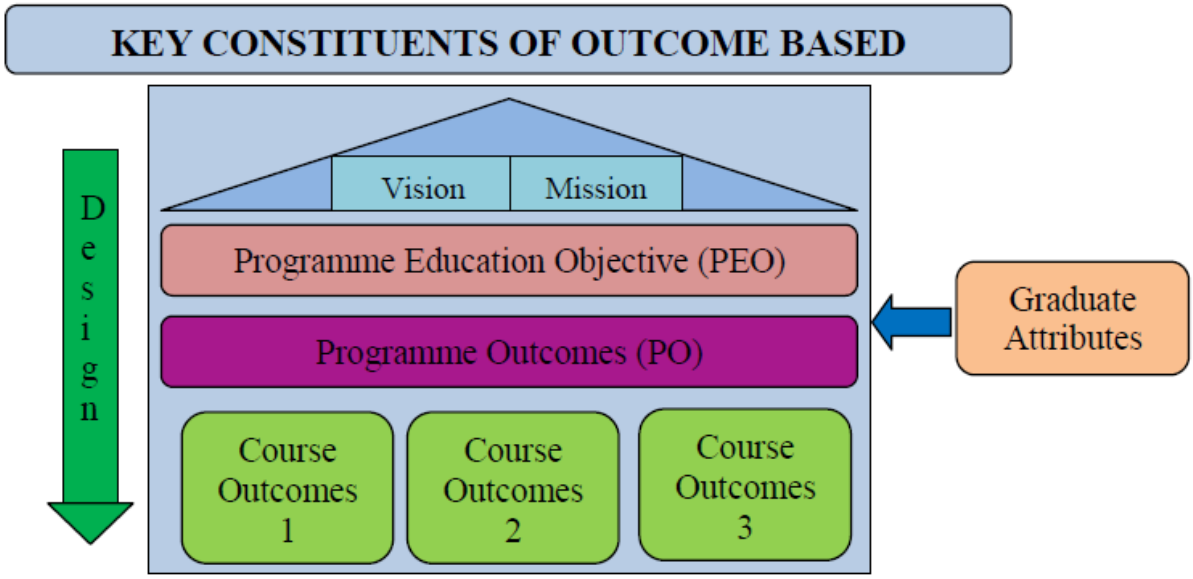


Figure 1: OBE flows and desciption

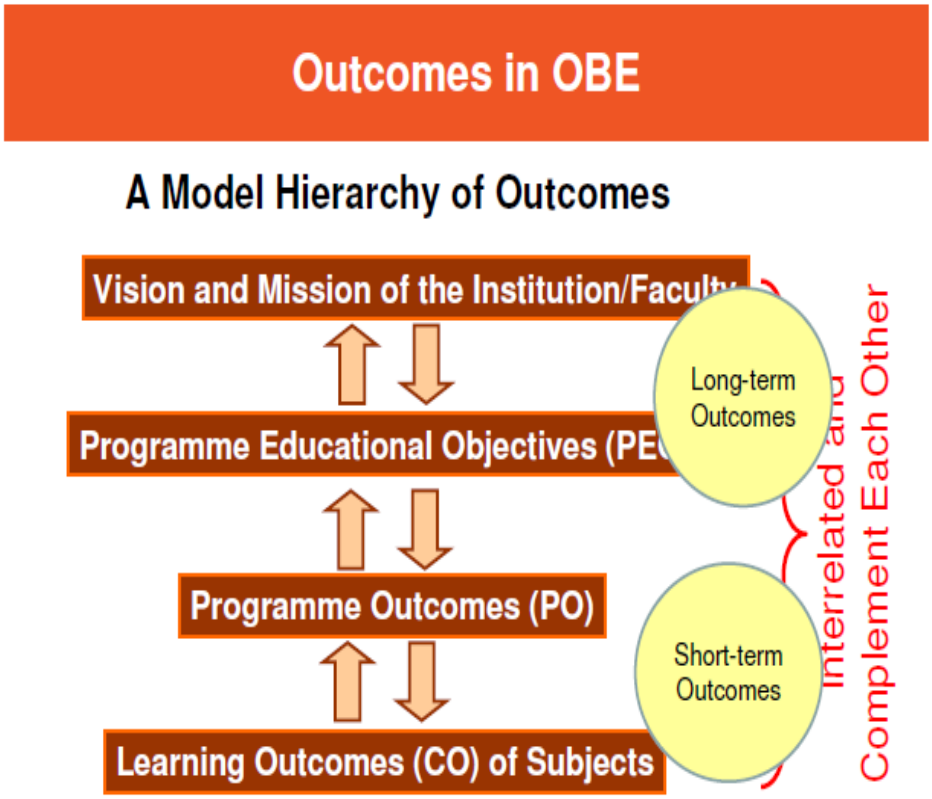


The OBE model measures the progress of the graduate in three parameters, which are

- Program Educational Objectives (PEO)
- Program Outcomes (PO)
- Course Outcomes (CO)

Program Educational Objectives (PEO) are broad statements that describe the career and professional accomplishments that the program is preparing the graduates to achieve. PEO's are measured 4-5 years after graduation. Program outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. They must reflect the Graduate attributes. Course outcomes are the measurable parameters which evaluates each student's performance for each course that the student undertakes in every semester.

The various assessment tools for measuring Course Outcomes include Tests and End Semester Examinations, Tutorials, Assignments, Project work, Labs, Presentations, Employer/Alumni Feedback etc. These course outcomes are mapped to Graduate attributes and Program outcomes based on relevance. This evaluation pattern helps Institutions to measure the Program Outcome. The Program Educational Objective is measure through Employer satisfaction survey (Yearly), Alumni survey (Yearly), Placement records and higher education records.



Special Features of OBE

- OBE is an educational process that focuses on what students **can do**or the **qualities** they should develop after they are taught.
- OBE involves the restructuring of curriculum, assessment and reporting practices in education to reflect the achievement of high order learning and mastery rather than accumulation of course credits.
- Both structures and curricula are designed to achieve those **capabilities** or **qualities**.
- Discourages traditional education approaches based on direct instruction of facts and standard methods.
- It requires that the students demonstrate that they have learnt the required skills and content.

Sanjay Ghodawat University Kolhapur

(Established as a State University under Government of Maharashtra Act No XL dated 3rd May 2017)

Academic and Examination Rules and Regulations

Approved in the sixth Academic Council Meeting held on 17th February, 2020
and to be implemented from academic year 2020-21. [Version R1]

Sanjay Ghodawat University Kolhapur

Kolhapur - Sangli Highway, A/p Atigre - 416 118,
Tal. - Hatkanangale, Dist. Kolhapur,
Maharashtra, India

(Implemented from Academic year 2020-21)

Academic and Examination Rules and Regulations

1.0 Preamble

The Sanjay Ghodawat University (SGU) stands as a beacon of light to guide the younger generation of the day on the right path to fulfillment in career and life. Outcome Based Education (OBE) model is adopted to enhance the effectiveness of teaching learning process and Credit Based semester system is implemented.

The focus of the University is its research based curriculum and academically oriented teaching staff. The world class ambience and infrastructure helps the students to easily accommodate themselves in an environment that is conducive to the teaching- learning process. Hands on experience, challenge based case studies, maximum participation of students in the classroom, use of modern digital technology, smart classrooms, solution oriented thinking promotion, stress on research and innovation, international tie ups, choice based credit system for flexibility in choosing areas of interest etc. are some of the features of the University.

Vision of SGU is internationally recognized university of excellence in creating and disseminating knowledge through value-based quality education leading to betterment of mankind. To achieve the vision SGU will develop state-of-the-art infrastructure that promotes conducive ambience promoting innovation and research. Create intellectual manpower relevant to the industry and society at large. Foster mutually beneficial partnership with alumni, industry and academia. Inculcate ethics and values to develop socially responsible citizens and promote entrepreneurship.

SGU is offering various programs through schools such as School of Technology, School of Commerce and Management, School of Sciences and School of Arts.

SGU has implemented the outcome based Education (OBE) system and Credit based Evaluation System in all the schools.

The rules and regulations mentioned in this document are applicable to all the Under Graduate (UG) and Post Graduate programs offered by the Sanjay Ghodawat University from the academic year 2018-19. The rules and regulations stated here under are subjected to revisions / refinements, updates and modifications and amendments by academic council (AC) from time to time and applicable to all batches including those already undergoing programs at different year and are binding on all stakeholders including students, faculty, parents and University authorities.

The academic programs of the University shall be governed by rules and regulations approved by the academic council from time to time. Academic council is the supreme and statutory academic body that governs all academic matters of the university and the decisions of the academic council are final and binding in the matters related to academics.

2.0 Definition of Terms

1. University: University means Sanjay Ghodawat University, Kolhapur
2. Academic Year: The period of the year during which students attend university for all academic

activities, usually it starts from first of July and ends on 30th of June next year.

3. Semester**:** Academic Year is divided in to 2 parts called Semester, Odd Semester which starts from July and Even Semester which starts from January.
4. Duration of Semester: Total duration of semester is usually 20 weeks per semester including instructions, examination and evaluation. Total instructional days are 90 per semester.
5. **Course:** It is a Subject that is offered in a semester. The course may consist of Theory/Practical/Project/Seminar during semester. Usually taught by instructor in a class. e.g. Physics, Chemistry, Engineering Mechanics, Workshop etc.
6. **Program:** Collection of Courses is called Program. For example, B Tech in Mechanical Engineering, M Tech in Civil Engineering, Bachelor of Business Administration. Bachelor of Science etc.
7. **Department:** Department is a unit of the school which offers one or more programs.
8. **Contact Hours:** Time of students in class/laboratory with instructor. Usually in the range of 20-30 Hrs. /Week. For the purpose of uniformity one contact hour is measured as 60 minutes
9. **Academic Council (AC):** Means apex academic body governing the academic programs responsible for framing policy, rules and regulations.
10. Board of Examination (BOE): Central body responsible for framing policy, rules and regulations for Examination.
11. Board of Studies (BOS): Departmental academic body to govern the academics of programs (BOS) offered by department.

3.0 Curriculum:

Every program has a prescribed structure which, in general, is known as Curriculum. It prescribes courses to be studied in each semester. The booklet containing courses structure along with detail syllabus for each course of each program is updated periodically and made available on the website.

3.1 Semesters:

SGU implements a credit based semester system. The academic year is divided into two regular semesters. The semesters that begin in July are known as Odd semester and the semester that begin in January are known as even semesters. Total duration of each semester is generally of 20 weeks including the period of examination, evaluation and grade declaration.

3.2 Course Credit System/Structure:

In general, a certain quantum of work measured in terms of credits is laid down as the requirement for a particular program. Calculation of number of credits for a course in any semester is as per Table 3.1

Table 3.1: Calculation of number of credits for a course

Sr. No.	Course	Credits
1	Lecture of 1 hour/week	**1**
2	Tutorial of 1 hour/week	**1**

3	Practical / Laboratory / Drawing/mini-project of two hours/ week	**1**
4	Seminar (1 hour per week)	**1**

There are mainly two types of courses- viz. Theory courses and Laboratory courses. Generally a theory course consists of Lecture hours (L) and Tutorial hours (T). Tutorial hours may not be assigned to a particular theory course if it has a separate laboratory course. Laboratory course consists of practical hours (P) for which a student works in a Laboratory/Drawing Hall/Workshop. The other courses required to be taken by a student include seminar, mini project, and project at various levels of the program.

A student shall earn credits for a particular course by fulfilling the minimum academic requirements for attendance and evaluation. No credits shall be awarded if a student satisfies the minimum attendance requirements but fails to meet minimum evaluation requirements.

The total number of credits required for completing a program shall be mentioned in the course structure. The total number of credits in a semester which a student registers shall generally be 20--25. The maximum number of credits per semester shall not exceed 30

3.3 Audit Course:

3.3.1 A student may have to register for an audit course in a semester which could be institute requirement or department requirement.

3.3.2 An audit course may include either a) a regular course required to be done as per structure or required as pre-requisite of any higher level course or b) the programs like practical training, industry visits, societal activities etc.

3.3.3 Audit course shall not carry any credits but shall be reflected in Grade Card as "PP"/"NP" depending upon the satisfactory performance in the semester evaluation as per the course curriculum structure.

4.0 Course Registration:

4.1 Every student must register for the courses that he/she wants to study for earning credits at the beginning of each semester on the prescribed dates announced from time to time and shall be mandatory for every student till he/she completes the program. Only after registration his/her name shall appear in the roll list of each of such courses.

4.2 Students shall be required to fill up a Course Registration Form which shall be made available to them by the Student section of Administration office after payment of required fees.

4.3 Registration, according to rules, should be carried out as per the schedule given in academic calendar. Late registration may be permitted only for valid reasons and on payment of late registration fees. In any case, registration must be completed before the prescribed last date for registration, failing which his/her studentship shall be liable to be cancelled. Students having dues outstanding towards the institute or hostel shall be permitted to register only after clearing such dues.

4.4 In-absentia registration may be allowed only in rare cases at the discretion of the Dean Academics and with prior permission.

4.5 For registration in an odd semester, the student must have earned all the credits of the pre-previous year and at least 75% 2/3rd of the credits previous year. For example, for registration of the 5th semester courses (i.e. 3rd year of program), a student must have earned all the credits of the first year and 2/3rd of the credit second year. Similarly, for registration of the 7th semester courses (i.e. 4th year of program), a student must have earned all the credits of the second year and 2/3rd of the credits third year. However, if 2/3rd of the calculation turns out to be a mixed number (integer + fraction) then only the integer part of that number shall be considered for taking decision related with this clause.

4.6 A student registered in odd semester shall be eligible to register for the courses offered in the even semester of that year irrespective of his/her SGPA or the number of credits earned by him/her in that odd semester.

5 .0 Lateral Entry for B Tech Programs

Post diploma students in engineering and B.Sc. Graduates can have lateral entry at third semester of the program. Such admissions are governed by the rules of regulatory bodies like AICTE New Delhi and Directorate of Technical Education Maharashtra state and Sanjay Ghodawat University for Admission criteria and shall undergo all academic requirements as specified by the Academic council.

For such students there shall not be First Year Performance Index (FYPI). Semester Performance Index (SGPA) and Cumulative Performance Index (CGPA) shall be calculated from the third semester onwards taking into consideration the courses undergone by them at Sanjay Ghodawat University Kolhapur.

Registration of the students not covered by the cases mentioned above shall be decided by the Academic Council. Such students shall undergo the academic program as specified by the Academic Council. Such odd entry students shall not be eligible for any medals or awards instituted by the institute.

6.0 Change of Program:

This is applicable to B Tech Programs only. Students shall be eligible to apply for Change of Program after completing the first two semesters. The following rules/ guidelines shall be used for considering their applications for change:

6.1 The change of program shall be permitted strictly on merit basis subject to the rules of admissions prevailing at the time of such change.

6.2 Students without fail grades and/or backlogs shall be eligible to apply for change of program and can give their choices in the order of preference.

6.3 The request for change of program by a student from program A to program B shall be considered if number of students of program B does not exceed the sanctioned capacity of program B and also the minimum strength required to run the program as decided by Academic Council.

6.4 All such transfers can be effected only once at the beginning of the second academic year of the 4-year UG program. No application for change of program during subsequent academic years shall be entertained.

7. Facilitation to Students:

7.1 Faculty Advisor:

On joining the institute, a student or a group of students shall be assigned to a faculty advisor who shall be mentor for a student throughout his/her tenure in the institute. A student shall be expected to consult the faculty advisor on any matter relating to his/her academic performance and the courses he/she may take in various semesters / summer term. A faculty advisor shall be the person to whom the parents/guardians should contact for performance related issues of their ward. The role of a faculty advisor is as outlined below:

The role of the Faculty Adviser is outlined below:

a. Guide the students about the rules and regulations governing the courses of study for a particular degree.
b. Advise the students for registering courses as per curriculum given. For this purpose, the Faculty Adviser has to discuss with the student his/her academic performance during the previous semester and then decide the number and nature of the courses for which He/ She can register during the semester as per the curriculum.
c. Approve the registration of the students.
d. Advice students to overload/ drop one or more courses/activities based on her/his academic performance as per the prescribed rules.
e. At the end of the first semester/year, the Faculty Adviser may even advise a reduced load program for a poorly performing student.
f. Pay special attention to weak students and carefully monitor performance of students recommended for slow track option.
g. Advice students for Course Adjustment / Dropping of courses during the Semester within the stipulated time frame given in the Academic calendar.
h. Advice students seeking semester drop either during the ongoing semester or before the commencement of the semester. FA has to ensure strict compliance of rules and regulations laid down for this purpose. Recommend the cases to the appropriate authorities for consideration.
i. Make revised plan of study for weak/bright students based on their semester wise performance.
j. Suggest modalities for course/credit requirements for the students recommended for exchange program.
k. Guidance and liaison with parents of students for their performance.
l. To ensure that students are not permitted to reregister for courses, which they have already passed.

m. Inform students that any academic activity (course / Lab. / seminar / project / noncredit requirement etc.) undergone without proper registration will not be counted towards the requirements of his/her degree.
n. Strictly warn students that if she/he fails to register during any semester without prior approval, his/her studentship is liable to be cancelled.
o. Keep the students updated about the Academic Administration of the University.

7.2. Helping Weaker Students:

A student with backlog/s should continuously seek help from his/her faculty advisor, Head of the Department and the Dean of respective schools. Additionally, he/she must also be in constant touch with his/her parents/local guardians for keeping them informed about academic performance. The university also shall communicate to the parents/guardians of such student at-least once during each semester regarding his/her performance in in-in various tests and examination and also about his/her attendance. It shall be expected that the parents/guardians too keep constant touch with the concerned faculty advisor or Head of the Department, and if necessary - the Dean of the respective school.

8.0 Discipline and Conduct:

8.1 Every student shall be required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity, which shall tend to bring down the prestige of the university.

8.2 Any act of indiscipline of a student reported to the Dean, Student Development, shall be discussed in a Disciplinary Action Committee of the institute. The Committee shall enquire into the charges and recommend suitable punishment if the charges are substantiated.

8.3 If a student while studying in the university is found indulging in anti-national activities contrary to the provisions of acts and laws enforced by Government, he/she shall be liable to be expelled from the institute without any notice.

8.4 If a student is involved in any kind of ragging, the student shall be liable for strict action as per provisions in the Maharashtra anti-ragging act.

8.5 If any statement/information supplied by the student in connection with his/her admission is found to be false/ incorrect at any time, his/ her admission shall be cancelled and he/she shall be expelled from the university and fees paid shall be forfeited.

8.6 If a student is found guilty of malpractice in examinations, then he/she shall be punished as per the recommendations of the Grievance Redressed Committee (CRC) constituted by Board of Examinations.

8.7 Every admitted student shall be issued photo identification (ID) card which must be retained by the student while he/she is registered at Sanjay Ghodawat University Kolhapur. The student must have valid ID card with him/her while in the University Campus.

8.8 Any student who alters or intentionally mutilates an ID card or who uses the ID card of another student or allows his/her ID card to be used by another, student shall be subjected to disciplinary action.

8.9 The valid ID card must be presented for identification purpose as and when demanded by

authorities. Any student refusing to provide an ID card shall be subjected to disciplinary action.

8.10 Students should switch off the Mobiles during the Instructional hours and in the academic areas of university Building, Library, Reading room etc. Strict action will be taken if students do not adhere to this.

8.11 During the conduct of any Tests and Examination students must not bring their mobiles. A student in possession of the mobile whether in use or switched off condition will face disciplinary action and will be debarred from appearing for the Test / Examination.

9.0 Academic Calendar

The academic activity of the University are regulated by Academic Calendar and is made available to the student's/ faculty members and all other concerned in electronic form or hard copy. It shall be mandatory for students / faculty to strictly adhere to the academic calendar for completion of academic activities.

10. Attendance:

10.1 Regular 100% attendance is expected from all students for every registered course in lectures, tutorial, laboratory, projects, mini-projects and other courses mentioned in program curriculum. Hence, attendance is compulsory and shall be monitored during the semester rigorously. Students shall be informed at the end of every month if they are failing short of attendance requirements.

10.2 A Maximum of 25% absence for the attendance may be permitted only on valid grounds such as illness, death in family of blood relations (Father, Mother, Sister, and Brother) and any other emergency reason which is beyond the control of the student and shall be approved by the authorities in respective departments.

10.3 If a student fails to put up 75% attendance individually in each course, the student will be put under X grade category and student will be debarred form attending the End Semester Examination (ESE) and Re-Exam for that semester in that course. However, student has an option to re-register for the course whenever it is offered next time or he can appear for 100% examination for which he will be awarded two grade penalties. Student's FET, CAT1 and CAT2 marks are treated as null and void.

10.4 The maximum number of days of absence for students participating in Co-curricular activities /Sports/ Cultural events during a semester shall not exceed 10. Any waiver in this context shall be on the approval of the Academic council only after the recommendation by Dean Academics of the university.

The HOD and Dean of the respective school shall report and recommend to Academic council the cases of students not having 75% attendance as per the records of course instructor. After rigorously analyzing these cases AC may take a decision to debar such student from End-Semester Examination (ESE) for that course. Such a student shall re-register for that course as and when it is offered next. ISE and MSE evaluations of such a student for this course during regular semester shall be treated as null & void.

10.5 A student remaining absent during ESE of a course either on medical ground (Accident and/or hospitalization of a student) or any other emergency circumstances (death of

immediate close relative i.e. father, mother, brother and sister) or due to representing University at university/state level in sports/co-curricular activities shall be treated as per the rules of Sec 13.6.2 and 12.1.2

The critical cases of absenteeism which are not covered by any of the above clauses shall be reported by concerned Head of Department to Academic dean and all such cases the decision of Academic council is final**.**

11. Modes of Assessment:

11.1 Assessment of Theory Courses:

11.1.1 A student shall be evaluated for his/her academic performance in a theory course through Faculty Evaluation Theory (FET), Continuous Assessment Tests (CAT1 and CAT2) and End Semester Examination (ESE).

11.1.2 The relative weightage for the theory courses having ESE shall be generally as shown in the Table 11.1.2

Table 11.1.2: Weightage for the theory courses in %

Exam→ Credits↓	FET	CAT1	CAT 2	ESE
4	20	15	15	50
2	20	-----	30	50

The details of the weightage of each course shall be listed in the structures of each program

11.1.3 FET shall be based on student's performance in assignments, quizzes, seminars, Course projects and field assignments, term papers, etc. The mode of FET shall be decided and announced by the Course Instructor at the beginning of the course.

11.1.4 CAT1 shall generally be of one-hour duration for each course and shall be held as per the schedule declared in the Academic calendar for that Semester.

11.1.5 CAT2 shall generally be of one-hour duration for each course and shall be held as per the schedule declared in the Academic calendar.

11.1.6 ESE is of three hours comprehensive examination for 4 credits course's is of two hours comprehensive examination for 2 credits course.

Table 11.1.6: Unit wise distribution in exams will be based on following table.

Total Number of Units	Units for CAT1	Units for CAT 2	Mark weightage for units in ESE

6	1 & 2	3 & 4	Equal weightage for all unit
5	1	2 & 3	Equal weightage for all unit
4	1	2	Equal weightage for all unit
3	Nil	1	Equal weightage for all unit
2	Nil	1	Equal weightage for all unit

11.1.7 All examinations and evaluations shall be compulsory. Credits for a course shall be awarded only if a student satisfies evaluation criteria and acquires the necessary minimum grade.

11.1.8 There shall be no re-examination for CAT1 and CAT2 of the courses having all the three components of evaluation viz. FET, CAT1 CAT2 and ESE. However, a student remaining absent for CAT1 and CAT2 for representing the University in state level or university level sports/co-curricular activities. (on prior recommendation and approval) or on valid grounds such as illness, death in family or other emergency reason which is beyond control of a student (on approval by the head of department and dean of respective school shall be considered for Make- up examinations).

11.1.9 A student remaining absent for ESE of a course either due to medical reason (Accident and/or hospitalization of a student) or other emergency circumstances (death of immediate close relative i.e. father, mother, brother and sister) or due to representing Sanjay Ghodawat University at University/State/National/International level in sports/co-curricular activities shall be awarded with grade "I". Such a student shall be allowed to appear for make-up examination scheduled along with re-examinations of other courses. The student shall apply to COE with proper documentary evidence to appear for make-up examination. After make-up examination, a student shall be entitled to an appropriate grade as per Table I of Sec. 11.1.2 based on his/her performance during the regular semester and in make-up examination.

Assessment of Laboratory Courses:

11.2.1 The assessment of laboratory course shall be continuous and based on turn-by-turn supervision of the student's work and the quality of his/her work as prescribed through laboratory journals and his/her performance in viva-voce examinations uniformly distributed throughout the semester. Where ESE for the laboratory course is specified ESE shall be based on performing an experiment followed by an oral examination. The relative weightage for FEP and ESE for assessment of laboratory courses shall be 50% each for FEP and ESE and a minimum performance of 40% in both ISE and ESE separately shall be required to get the passing grade.

11.2.2 ESE for laboratory course shall normally be held before the ESE for theory courses and shall be conducted by a panel of examiners appointed by COE from the panel of experts approved by BOS. This activity shall be coordinated by Department Examination

Coordinator (DEC) in consultation with HOD of the respective department.

11.2.3 Student failed in ESE of a laboratory course in a regular semester shall be eligible to appear for 100% examination conducted along with ESEs of laboratory courses of the subsequent semester. Such examination shall be fairly comprehensive (generally of 3 hours similar to POE i.e. Practical-Oral-Examinations) to properly judge his/her practical skill and theoretical knowledge for that laboratory course. He/ She shall suffer one grade penalty.

12.0 The Grading System:

Absolute Grading System (AGS) is adopted based on absolute numerical marks obtained by the student during all stages of evaluation for a course.

12.1 Award of Grade (Regular Semester):

12.1.1 For every course registered by a student in a semester, he/she shall be assigned a grade based on his/her combined performance in all components of evaluation scheme of a course as per the structure. The grade indicates an assessment of the student's performance and shall be associated with equivalent number called a grade point.

12.1.2 The academic performance of a student shall be graded on a ten-point scale. The Absolute Grading System is followed. Letter grades, the guidelines for conversion of marks to letter grades and their equivalent grade points are as given in Table.

Table 12.1.2: Grade Table for Regular Semester

Marks Obtained	Grade Letter GL	Grade Point GP	Performance Description
90-100	**O**	**10**	Outstanding
80-89	**A+**	**09**	Excellent
70-79	**A**	**08**	Very Good
60-69	**B+**	**07**	Good
50-59	**B**	**06**	Above Average
45-49	**C**	**05**	Average
40-44	**P**	**04**	Pass
00-39	**F**	**00**	Fail

-	**AB**	**00**	Absent
-	**X**	**00**	Detained (Failed)
-	**Satisfactory**	-	Pass in Non-Credit Courses
-	**Un Satisfactory**	-	Failed in Non-Credit Courses

12.1.3 A student shall pass the course if he/she gets any grade in the range "O" to “P".

12.1.4 “FF" grade shall be awarded to a student in a course if he/she gets less than 40% marks jointly in the FET, CAT1, and CAT2 & ESE for a theory course and in FEP& ESE for a laboratory course. A course shall then be eligible to apply for re-examination. A student failed in laboratory course shall be eligible to apply only for 100% examination conducted with the laboratory examinations of the subsequent semester. In both cases, a student has to suffer one grade penalty.

13 Assignment of X Grade

Grade "X" in a regular course shall be given to a student if he/she falls in any of the following categories.

13.1 A student does not maintain the minimum 75% attendance in any of the theory or laboratory courses.

13.2 A student has not completed most of the Evaluations like FET, CAT1 and CAT2 due to non-medical reasons (for example when a student has missed all or most of the components of internal evaluation conducted by the instructor in that semester).

13.3 The performance of a student is less than 40% in FET, CAT1 and CAT2 Combined.

13.4 A student is guilty of any academic malpractice during semester (Such cases shall be dealt by Grievance Redressed and Discipline Committee).

In above four cases grade "X" shall be declared one week before ESE and intimated to the Academic Office and COE immediately thereafter. Such a student shall not be permitted to take the ESE of that course.

13.5 Grade "X" may be given to a student if

13.5.1 A student eligible for ESE remains absent for ESE of a course with no written intimation to Exam Cell within four days after the respective ESE is over.

13.5.2 A student is guilty of any academic malpractice during examination. (Such cases shall be dealt by Grievance Redressal Committee).

In 13.5.2 grade "X" in that course shall be declared after Grievance Redressed Committee confirms the academic malpractice.

In above two cases when a student gets "X " grade in a course, then this shall be treated as "FF" for the purpose of calculation of Semester Performance Index (SGPI) and First Year Performance Index (FYPI) or Cumulative Performance Index (CGPI).

13.6 Following rules apply to the student who has obtained grade "X" in a regular semester:

13.6.1 A student obtaining grade "X" in a course in a regular semester or during examination shall be not be allowed to appear for End semester examination and also Re ESE conducted before the beginning of the next semester. His/her FET, CAT1 and CAT2 evaluations for all courses shall be treated as null and void. His/her needs to re-register for courses of that semester in the next academic year whenever they are offered and undergo all evaluations along with fresh regular students for which he will get one grade penalty.

13.6.2 Grade "I" shall be declared in a theory/laboratory course if a student has satisfactory performance FET, CAT1, CAT2 and has fulfilled the 75% attendance requirement, but has not appeared for ESE due to genuine reasons. Such students shall be eligible for the make-up examination of ESE only on medical grounds/valid reasons and on production of authentic medical certificate or other supporting document/s (as required by the University) to the COE within ten days after the respective examination is over. The application form with requisite amount of fees must be submitted to the Exam Cell before the last date of filling such application forms for make-up examinations. These examinations shall be based on 100% syllabus and shall be scheduled before the commencement of the subsequent semester for theory courses and along with ESEs of laboratory courses of the subsequent semester. A student with "I" grade when appears for the make-up examination shall be eligible to obtain a regular performance grade ("O" to "F") as per Table 11.1.2 depending on his/her overall performance in FET, CAT 1, CAT 2 and make-up examination. If a student fails to appear for make-up examination too, a grade "XX" shall be awarded to him/her. Thus "I" is only a temporary grade and shall be replaced by a valid grade only after make-up examination.

13.6.3 There shall be a few audit courses as per the policies of the institute or as decided by DPC of respective program. The grade "PP" (Passed)/ "NP" (Not Passed) shall be awarded for such courses depending upon the performance of a student evaluated by the faculty in-charge. No grade points shall be associated with these grades and performance in these courses shall be not taken into account in the calculation of the performance indices (SGPI, CGPI). However, the award of the degree shall be subject to obtaining a "PP" grade in all such courses.

14. Award of Grades for Re-Examination:

14.1 A student who has obtained grade "F" in regular semester shall be eligible to appear for re-examination conducted before the commencement of the next regular semester. In such cases FET, CAT1 and CAT2 marks are carried forward and a student has to suffer one grade penalty

14.2 A student shall apply for re-examination before the last date of such application and shall appear for re-examination.

14.3 50% weightage similar to ESE shall be given to re-examination and there is one grade penalty.

14.4 A student who has obtained "F" grade in ESE of a regular semester and has not availed re-examination option or a student who has obtained "F" grade in both ESE and re-examination shall be eligible to choose one of the two options below to clear his/her backlog:

- Re-registration for the next regular semester course whenever that course is offered.
- Appearing for ESE of the course when conducted...
  A student detained in a regular semester due to either a) by obtaining "X" grade or b) by involvement in academic malpractice or c) by breaking the institute code of conduct and discipline can re-register for the course when offered next.

Following rules apply for these cases:

14.5 In first case i.e. Re- registration the earlier performance of a student in all the evaluations of that course shall be treated as null and void. The student has to undergo all the evaluations after re-registration.

15. Grades for Third and Subsequent attempts:

If A student opts for ESE or Re ESE who previously had obtained grade "F" in a course in two attempts, his/her FET, CAT1 and CAT2 performance of the regular semester shall be considered for evaluation and His/her has to suffer two grade penalty for the third attempt and for 4th and subsequent attempts shall be awarded a grade "P" or "F" or "X" based on his/her performance. However, if a student takes more than three chances (regular examination being the first chance, re-examination being the second chance, to clear a course, then the maximum passing grade that he/she can get shall be only "P". Thus a student has to suffer a grade penalty by accepting a lower grade than that obtained in the regular examination, re-examination, or examination for a re-registered course.

16. CALCULATION OF PERFORMANCE INDICES:

16.1. Semester Grade Point Average (SGPA)

The performance of a student in a one specific semester is indicated by SGPA. SGPA is a weighted average of the grade points obtained in all courses registered by the students during the semester. SGPA can be calculated by following equation.

$$SGPA = S_i = \frac{\sum_{i=1}^{n} C_i P_i}{\sum_{i=1}^{n} C_i}$$

Where, i = 1, 2, 3……. n is number of courses during semesters. C = No of credits associated with that course and P = Grade point earned in that course. SGPA will be rounded off to two decimal places.

16.2 Cumulative Grade Point Average (CGPA)

The total cumulative performance of a student at the end of specific semester is indicated by CGPA. An up-to-date assessment of the overall performance of a student for the courses from the first semester onwards till completion of the program shall be obtained by calculating Cumulative Grade Point Average (CGPA).

CGPA is a weighted average of the SGPA obtained in all semesters by the students during the semesters. CGPA can be calculated by following equation.

$$CGPA = \frac{\sum_{j=1}^{n} C_j S_j}{\sum_{j=1}^{n} C_j}$$

Where, j = 1, 2, 3……. n is number of semester during program. C = Total No of credits in the semester for which CGPA is to be calculated.

CGPA will be rounded off to two decimal places.

Conversion of CGPA to percentage marks for CGPA ≥ 4.5 can be obtained using equations. Percentage marks = (CGPA x 10) – 7.5.

16.3 For the students acquiring "I" grade (which is only a temporary grade) in any of the courses, SGPA, CGPA shall be calculated only after make-up examination.

17. First Year Performance Index (FYPI): (Applicable for B. Tech Programs Only)

17.1 For a student registered in Sanjay Ghodawat University Kolhapur right from the First semester, First-Year-Performance-Index (FYPI) shall be calculated as weighted average of the grade points obtained in all the courses registered by him/her in semesters I and II only.

$$\text{FYPI} = \frac{\sum_{i} C_i g_i}{\sum_{i} C_i}$$

Where summation is for all the courses registered by a student in first two semesters. FYPI shall be calculated when for the second semester is calculated. FYPI shall be rounded off to two decimal places.

17.2 FYPI shall reflect all the courses undergone by a student in the first year including the courses in which he/she has failed. FYPI may get modified in the subsequent semesters whenever a student clears his/her first year backlog courses.

17.3 If a student has been awarded "I" grade in the regular semester course of the first year then, FYPI shall be calculated after the make-up examination on the basis of the grade obtained by that student in a make-up examination.

17.4 If a student has obtained grade "F" or "X" at any time in any of the courses registered by him, then zero grade points corresponding to these grades shall be taken into consideration for calculation of FYPI.

18 Maximum Duration for Completing the Program

Maximum duration for completing any program UG/PG offered by Sanjay Ghodawat University is respective program duration plus two additional years.

Maximum duration for getting the B. Tech degree for students admitted in the first semester of UG program is, program duration plus two additional years (i.e. 12 Semesters and 6 academic years) For lateral entry student academic admitted in the third semester shall be (10 Semester and 5 Years).

The maximum duration of the program includes the period of withdrawal, absence and different kind of leaves permission to student but excludes the period of rustication of the student from the university however genuine case a confidential of valid reason may be referred to academic council for extending this limit by additional criteria

19 NFTE (Not Fit for Technical Education) (Applicable to B Tech program only)

It is mandatory for the student to earn all credits of first year specified for semester I & II or eligible for ATKT as per the rules to seek admission to semester III of second year in three years from the date of admission to avoid NFTE. If a student fails to become eligible for admission to Semester III in three year form the date of his admission, he shall be declared as "Not Fit for Technical Education" leading to discontinuation of his/her registration with the university. Such cases should be put up in the academic council.

20. Academic Progress Rules (ATKT Rules):

20.1 A student shall be allowed to register for the courses of the next year's odd semester only if he/she has earned all the credits of the previous year and has earned at least 2/3rd credits of the current year. If 2/3rd calculation turns out to be a mixed number (integer + fraction) then only the integer part of that number shall be considered for deciding the eligibility for ATKT.

(a) At the end of 1st year a student shall be allowed to keep terms (ATKT) to 2nd year of study provided he/she attends course work prescribed for 1st year with prescribed attendance and successfully earned at least 2/3rd of the total credits specified for 1st year program.

For Example: Total credits for B. Tech first year 2017-18, are 45 (Total of Semester I and II). A Student should earn minimum 2/3rd of the 45 Credits i.e. A student can go to next higher class with a maximum backlog of 1/3rd credits of semester I & II of the first year.

Student, who fails to earn those credits, cannot register for next semester, either it can re-registrar for the course and credits or can use the next opportunity to earn the credits when exams are conducted.

(b) At the end of 2nd year a candidate shall be allowed to keep terms to 3rd year of study provided he/she attends course work prescribed for 2nd year with prescribed attendance, and successfully cleared 1st year program and at least 2/3rd of total credits prescribed for 2nd year program.

(c) At the end of 3rd year a candidate shall be allowed to keep terms to final year of study provided he/she attendants course work prescribed for 3rd year with prescribed attendance, and should have completed 2nd year program and 2/3rd of total credits prescribed for 3rd year program.

All such candidates fulfilling the above criteria shall be declared as FAILED, ATKT.

A student shall be allowed to take admission for odd semester of next academic year only if he/ she have earned all the credits of the previous year and 2/3rd happens to be a decimal, it is rounded to only integer part.

21. Semester Grade Report:

21.1 Semester grade report reflects the performance of a student in that semester (SGPI) and also his/her cumulative performance for the first year (FYPI) and also the cumulative performance since the third semester of his/her study (CGPA).

21.2 The semester grade card issued at the end of each semester/ summer term to each student shall contain the following.

- The credits for each course registered for that semester.
- Any audit course/s undertaken by a student in a Semester.
- The letter grade obtained in each course.
- The total number of credits earned by a student for the first year separately.
- The total number of credits earned by a student since the 3rd semester onwards.
- SGPI, FYPI, CGPI.
- A list of backlog courses, if any.
- Remarks regarding eligibility of registration for the next semester.

21.3 Semester grade card shall not indicate class or division or rank however a conversion from grade point index to percentage based on CGPI shall be indicated on the final grade card of the program.

22 Award of Degree:

Following rules prevail for the award of degree.

- A student has registered and passed all the prescribed courses under the general institutional and departmental requirements.
- A student has obtained CGPI $\geq$ 4.75.
- A student has paid all the institute dues and satisfied all the requirements prescribed.
- A student has no case of indiscipline pending against him/her.
- Academic Council shall recommend the award of degree to a student who is declared to be eligible and qualified for above norms.

23 Grace Marks

- Maximum total grace marks will be 1 % of the total theory credit courses x 100

subjected

- To maximum 6 marks in that semester.
- Grace marks will be given candidate for change in grades for theory credit courses.
- Fail to pass grade only and will be reflected in final ESE marks.
- The grace marks are applicable only for maximum 1/3rd courses (rounded to higher Integer part i.e. if there are 4 theory courses then 4/3 = 1.33 = 2 courses).
- Maximum grace marks will be distributed in maximum courses
- Benefit of grace marks is not applicable for any medal/award.
- Applicable to theory and (Theory + Practical Courses). If is not applicable for Practical courses.
- Scheme for grace marks only can be used when the student will pass in all courses of that semester.

24. CGPA Improvement Policy for Award of Degree:

An opportunity shall be given to a student who has earned all the credits required by the respective program with CGPA greater than or equal to 4.00 but less than 4.75 to improve his/her grade by allowing him/her to appear for ESE examinations of maximum two theory courses of seventh semester. Such examinations shall be scheduled along with re-examinations/make-up examinations. However, CGPA shall be limited to 4.75 even though the performance of a student as calculated through modified CGPA becomes greater than 4.75.

Conclusions:

The academic policies regarding conduct of programs in Sanjay Ghodawat University Kolhapur are published in this document. The Academic Council shall reserve the right to modify these policies as and when required from the point of view of achieving academic excellence. In special and abnormal cases (i.e. the cases not covered through above rules) the decision of the (Chairman, Academic Council shall be final and shall be binding on all concerned.

Chairman
Academic Council

First Year B.Sc.: Semester I										
Course Code	**Course Title Pass**	**L**	**T**	**Pr**	**C**	**Evaluation Scheme**				
						Component	**Exam**	**WT**	**Min Passing (%)**	
PHS101 (PC|SS)	Physics I	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
CHS101 (PC|SS)	Chemistry I	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
MTS101/ BOS101 (PC|SS)	Mathematics I / Botany-I	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
AES101 (UC|SA)	English Communication	2	-	-	2	Theory	FET	20	40	40
							CAT	30	40	
							ESE	50	40	
AES103 (UC|SA)	English Communication Lab	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
PHS103 (PC|SS)	Physics Lab I	-	-	4	2	Practical	FEP	50	40	
							POE	50	40	
CHS103 (PC|SS)	Chemistry Lab I	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
MTS103/ BOS103 (PC|SS)	Mathematics Lab I / Botany Lab I	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
Total		14	00	16	22	Total Hrs.: 30, Total Credits: 22				

L: Lecture, T: Tutorial, Pr: Practical, C: Credits, Th.: Theory, WT: Weight Age PC: Program Core, PE: Program Elective, UC: University Core, UE: University Elective ST: School of Technology, SS: School of Sciences, SC: School of Commerce, SM: School of Management, SA: School of Arts; FET: Faculty Evaluation Theory, FEP: Faculty Evaluation Practical's; CAT: Continuous Assessment Test, ESE: End Semester Examination.

First Year B.Sc.: Semester II										
Course Code	**Course Title**	**L**	**T**	**Pr**	**C**	**Evaluation Scheme**				
						Component	**Exam**	**WT**	**Min Passing (%)**	
PHS102 (PC|SS)	Physics II	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
CHS102 (PC|SS)	Chemistry II	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
MTS102/ BOS102 (PC|SS)	Mathematics II / Botany-II	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
AES102 (UC|SS)	Environmental Studies	3	-	-	3	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
AES104 (UC|SS)	Environmental Studies Project	-	-	2	1	Practical	FEP	50	40	40
							POE	50		
PHS104 (PC|SS)	Physics Lab II	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	40
CHS104 (PC|SS)	Chemistry Lab II	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
MTS104/ BOS 104 (PC|SS)	Mathematics Lab II/ Botany Lab II	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
Total		14	00	16	22	Total Hrs.: 30, Total Credits: 22				

Second Year B.Sc. (Chemistry): **Semester III**										
Course Code	**Course Title**	**L**	**T**	**Pr**	**C**	**Evaluation Scheme**				
						Component	**Exam**	**WT**	**Min passing (%)**	
PHS 201 (PC|SS)	Physics III	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
CHS 201 (PC|SS)	Chemistry III	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
MTS 201/ BOS 201 (PC|SS)	Mathematics III / Botany-III	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
(PC|SS)	Skill Enhancement course-I*	2	-	-	2	Theory	FET	20	40	40
							CAT	30		
							ESE	50	40	
PHS 205 (PC|SS)	Physics Lab III	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
CHS 205 (PC|SS)	Chemistry Lab III	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
MTS 205 / BOS 205 (PC|SS)	Mathematics Lab III / Botany Lab III	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
(PC|SS)	Skill Enhancement course Lab-I*	-	-	2	1	Practical	FEP	50	40	40
							POE	50	40	
CIS 201 (UC|SA)	Constitution of India & Professional Ethics	-	-	-	NC	Theory	ESE	100		40
	Total	14	00	14	21	Total Hrs.: 28, Total Credits: 21, Audit: 01				

Second Year B.Sc. (Chemistry): **Semester IV**										
Course Code	**Course Title**	**L**	**T**	**Pr**	**C**	**Evaluation Scheme**				
						Component	**Exam**	**WT**	**Min passing (%)**	
PHS 202 (PC|SS)	Physics IV	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
CHS 202 (PC|SS)	Chemistry IV	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
MTS 202/ BOS 202 (PC|SS)	Mathematics IV/ Botany IV	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
(PC|SS)	Skill Enhancement course-II*	2	-	-	2	Theory	FET	20	40	40
							CAT	30		
							ESE	50		
PHS 206 (PC|SS)	Physics Lab IV	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
CHS 206 (PC|SS)	Chemistry Lab IV	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
MTS 206 BOS 206 (PC|SS)	Mathematics Lab IV/ Botany Lab IV	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
(PC|SS)	Skill Enhancement course Lab-II*	-	-	2	1	Practical	FEP	50	40	40
							POE	50	40	
Total		14	00	14	21	Total Hrs.: 28, Total Credits: 21				

Third Year B.Sc. (Chemistry): Semester V										
Course Code	Course Title	L	T	Pr	C	Evaluation Scheme				
						Component	Exam	WT	Min passing (%)	
CHS 301 (PC|SS)	Organic Chemistry	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
CHS 303 (PC|SS)	Inorganic Chemistry	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
(PC|SS)	Discipline Specific Elective-I**	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50		
(UC|SS)	Skill Enhancement Course- III*	2	-	-	2	Theory	FET	20	40	40
							CAT	30		
							ESE	50		
CHS 317 (PC|SS)	Organic Chemistry Lab	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
CHS 319 (PC|SS)	Inorganic Chemistry Lab	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
(PC|SS)	Discipline Specific Elective-I Lab**	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
(PC|SS)	Skill Enhancement Course-III Lab*	-	-	2	1	Practical	FEP	50	40	40
							POE	50	40	
CHS 333 (PC|SS)	Mini Project Phase I	-	-	2	1	Practical	FEP	50	40	40
							POE	50	40	
Total		14	00	16	22	Total Hrs.: 30, Total Credits: 22				

Third Year B.Sc. (Chemistry): Semester VI										
Course Code	Course Title	L	T	Pr	C	Evaluation Scheme				
						Component	Exam	WT	Min passing (%)	
CHS 302 (PC|SS)	Physical Chemistry	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
CHS 304 (PC|SS)	Analytical Chemistry	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
(PC|SS)	Discipline Specific Elective-II**	4	-	-	4	Theory	FET	20	40	40
							CAT I	15		
							CAT II	15		
							ESE	50	40	
(UC|SS)	Skill Enhancement Course- IV*	2	-	-	2	Theory	FET	20	40	40
							CAT	30		
							ESE	50	40	
CHS 318 (PC|SS)	Physical Chemistry Lab	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
CHS 320 (PC|SS)	Analytical Chemistry Lab	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
(PC|SS)	Discipline Specific Elective-II Lab**	-	-	4	2	Practical	FEP	50	40	40
							POE	50	40	
(PC|SS)	Skill Enhancement Course-IV Lab *	-	-	2	1	Practical	FEP	50	40	40
							POE	50	40	
CHS 334 (PC|SS)	Mini Project Phase II	-	-	2	1	Practical	FEP	50	40	40
							POE	50	40	
Total		14	00	16	22	Total Hrs.: 30, Total Credits: 22				

*Select from pool of Skill Enhancement Courses below.

**Select from pool of Discipline Specific Elective Courses below.

Pool of skill enhancement courses

Sr. No	Course code (Theory)	Course code (Practical)	Course Name	Semester
1	CHS 203	CHS 207	Basic Analytical Chemistry	SEM- III
2	CHS 209	CHS 211	Fuel Chemistry	
3	CHS 204	CHS 208	Green Methods in Chemistry	SEM-IV
4	CHS 210	CHS 212	Computational Chemistry	
5	CHS 313	CHS 329	Pharmaceutical Chemistry	SEM-V
6	CHS 315	CHS 331	Mathematics for chemistry	
7	CHS 314	CHS 330	Pesticide Chemistry	SEM-VI
8	CHS 316	CHS 332	Chemistry of Cosmetics & Perfumes	

Pool of Discipline Specific Electives

Sr. No	Course code (Theory)	Course code (Practical)	Course Name	Semester
1	CHS 305	CHS 321	Analytical Methods in Chemistry	SEM-V
2	CHS 307	CHS 323	Chemistry of Materials	
3	CHS 309	CHS 325	Polymer science and technology	
4	CHS 311	CHS 327	Sustainable chemistry	
5	CHS 306	CHS 322	Utility of Industrial Chemistry	SEM-VI
6	CHS 308	CHS 324	Chemical products of Industrial Relevance	
7	CHS 310	CHS 326	Instrumental Methods of chemical Analysis	
8	CHS 312	CHS 328	Molecules of Life	

Note: Student should complete at least one NPTEL/SWAYAM/MOOC course for the completion of UG degree.

Total credits: 130

Sanjay Ghodawat University Kolhapur

School of Science Program: M. Sc.

Syllabus Structure for First Year B. Sc. R1

CHS 301: Organic Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description:

Course Outcomes: At the end of this course students will able to

CO1	Understand the terminology associated with conformational analysis.
CO2	Understand how to elucidation of structure of polynuclear hydrocarbons.
CO3	Explain[2] concepts and mechanism in heterocyclic organic compounds.
CO4	Explain[2] Alkaloids and Terpenes and their synthesis
CO5	Describe[2] lipids, oils and fats and structure and importance of pharmaceutical compounds:

Syllabus (Theory)

Units	Description	Hours
I	**Polynuclear hydrocarbons**: Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation an.d important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons. **Stereochemistry**: Conformational isomerism – Introduction, Conformations and conformational analysis of ethane and n-butane by Newmann's Projection formula with the help of energy profile diagrams, Cycloalkanes relative stability - Baeyer's strain theory, Theory of strainless rings, Conformations and stability of cyclohexane and monosubstituted cyclohexanes Cyclohexanol, bromocyclohexane and methyl cyclohexane, Locking of conformation in t-butyl cyclohexane, Stereospecific, Stereo-selective reactions with examples (Mechanism not expected).	15
II	**Heterocyclic compounds:** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and	15

iso-quinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction
Derivatives of furan: Furfural and furoic acid.

III **Alkaloids:** 15

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Terpenes:

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α- terpineol.

IV **Lipids**: Introduction to oils and fats; common fatty acids present in oils and fats, 15
Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Pharmaceutical Compounds: Structure and Importance:

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Reference Books:

1) Graham Solomans, T. W. Organic Chemistry, John Wiley & Sons Pvt. Ltd.
2) Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3) Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4) Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5) Bansal R. K. Heterocyclic chemistry (Wiley E).
6) P.S.Kalasi, Stereochemistry conformation & Mechanism, 9th Edition, Publisher: New Age International, 2017.
7) Eliel, Stereochemistry of carbon compounds.
8) D. Nasipuri, Stereochemistry of Organic Compounds.

CHS 303: Inorganic Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: It is a foundation course in inorganic chemistry and it covers learning of properties of main group elements, organometallic compounds and their chemistry, and the role of metal ions in the biology.

Course Outcomes: At the end of this course students will able to

CO1	Understand[2] the characteristic properties, structures and reactivities of s and p block elements.
CO2	Discribe[2] properties of noble gas compounds and inorganic polymers.
CO3	Explain[3] the chemistry of organometallic compounds.
CO4	Discuss[3] the role of metals in biological systems.
CO5	Explain[2] the periodic properties of the different groups of compounds focusing on production methods and application of selected elements and compounds.

Syllabus (Theory)

Units	Description	Hours
I	**Chemistry of s and p block elements**: Inert pair effect, Relative stability of different oxidation states, Diagonal relationship and anomalous behavior of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Borohydrides (diborane) carboranes and graphitic compounds, Silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxoacids of Sulphur, Interhalogen compounds, Polyhalide ions, Pseudohalogens and basic properties of halogens.	15
II	**Noble gases** : Occurrence & uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2 and XeF4, XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory). **Inorganic Polymers**: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.	15

III **Organometallic Compounds**: 15

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

IV **Bioinorganic Chemistry**: 15

Role of metal ions in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Hemoglobin: Storage and transfer of iron. Synthesis of Hemoglobin and Myoglobin.

Reference Books:

1) Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth- Heinemann. 1997.
2) Lee, J.D. Concise Inorganic Chemistry, ELBS (1991).
3) Canham, G.R. and Overton, T., Descriptive Inorganic Chemistry, Freeman &Co.2006
4) Cotton, F.A. and Wilkinson, G, Advanced Inorganic Chemistry, Wiley, VCH, 1999.
5) Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.

----------Discipline Specific Electives Sem-V----------

CHS 305: Analytical Methods in Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description:

The course is devoted to the characteristic features of absorption and emission spectroscopy particularly IR, UV-Visible, Flame emission spectroscopy. Students also studying the thermal, electroanalytical and solvent extraction methods of analysis.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] basic analytical concepts.
CO2	Understand[2] of chemical analysis and qualitative and quantitative aspects of absorption spectroscopy.
CO3	Apply[3] the knowledge absorption and emission spectroscopy to obtain structural and quantitative information of molecules in the materials
CO4	Understand[2] basic aspects of thermal and electroanalytical methods of analysis.
CO5	Understand[2] the theory and applications of solvent extraction methods in chemical analysis.

Syllabus (Theory)

Units	Description	Hours
I	**Basic aspects of chemical analysis:** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals. Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Qualitative aspects, geometrical isomers, keto-enol tautomers. Quantitative aspects, Estimation of metal ions from aqueous solution, determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.	15
II	**Infrared Spectrometry**: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution. Flame, Atomic Absorption and Emission Spectrometry:	15

Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

III **Thermal methods of analysis:** 15

Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

IV **Solvent Extraction Methods in Analysis:** 15

Solvent extraction: Classification, principle and efficiency of the technique.
Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Factors affecting extraction, Qualitative and quantitative aspects of solvent extraction: applications of liquid extraction. Extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media, Solvent extraction methods in metallurgy.
Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.

Text Books

01 Khopkar S M, Basic concepts of Analytical Chemistry, New Edge International Publishers.
02 Kalsi P.S. Spectroscope of organic compounds (New age publisher

Reference Books

01 Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.
02 Skoog D.A., Holler F. J. , Principles of Instrumental Analysis, 6th edition.
03 Harvey David, Modern Analytical Chemistry, McGraw Hill Publication, International Edition available as e-book.(www.mhhe.com
04 Willard H H, Meritt L L, Dean J A and Settle F A, Instrumental methods of Analysis. Wadsworth Pub Co;
05 Howard Strobel, Chemical Instrumentation: A Systematic Approach, Wiley.
06 Rouessac Francis and Rouessac Annick, Chemical Analysis: Modern Instrumentation Methods and Techniques.
07 Ewing G.W., Instrumental Methods of Analysis 4th and 5th editions. McGraw Hill Publisher.
08 Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis, (5th edition Revised Copy) Longmann Scientific and Technical jointly with John Wiley and Sons Inc.(PDF soft Copy available free on internet)
09 Kaur H., Instrumental Methods of Chemical analysis, Pragati Prakashan.
10 Glasstane Samuel, An Introduction to Electrochemistry, East-West Press Pvt. Delhi.

CHS 307: Chemistry of Materials

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: This course is at odd semester of third year of B.Sc. This course help student to acquire skills related to various synthesis methods for preparation of nano-materials and smart materials and explain the properties of materials used in construction as well as the composite materials.

Course Outcomes: At the end of this course students will able to

CO1	Describe[2] the Inorganic solids and synthesis method for the preparation of smart materials.
CO2	Explain[3] synthesis and properties of nano-materials.
CO3	Describe[1] the properties of materials of construction in engineering.
CO4	Discuss[2] the properties of composite materials.

Syllabus (Theory)

Units	Description	Hours
I	**Smart materials:** Introduction, synthesis, conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods. **Inorganic solids of technological importance:** Introduction, Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments. Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals.	15
II	**Nanomaterials:** Overview of nanostructures and nanomaterials: classification. Synthesis: top down and bottom up approach. Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.	15
III	**Introduction to engineering materials for mechanical construction:** Mechanical and physical properties of materials of construction in engineering, Stress, strain, Hookes law, stress-strain curve, elastic, plastic and repture behavior of materials, stiffness, toughness, hardness of materials, corrosion, types of corrosion and methods of prevention of corrosion. ferrous and nonferrous materials, various types of cast irons, plain carbon and alloy steels, copper, aluminium and their alloys like duralumin, brasses	15

and bronzes cutting tool materials, super alloys, thermoplastics, thermosets and ceramics.

IV **Composite materials:** 15

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites

Text Books

01 Poole, C.P. & Owens, F.J. Introduction to Nanotechnology John Wiley & Sons, 2003.

02 Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural Chemistry. John Wiley & Sons, 1974.

Reference Books

01 Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, 32

02 Gary D Christian, Analytical Chemistry 6^{th} edition, John Willey and Sons(2003)

03 Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

04 Fahlman, B.D. Materials Chemistry, Springer, 2004.

CHS 309: Polymer Science & Technology

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: The course is devoted to the core principles of synthesis and recent advancement in techniques of polymer synthesis.

Course Outcomes: At the end of this course students will able to

CO1	Describe[2] principles of synthesis of polymers.
CO2	Explain[2] the chemistry of polymers.
CO3	Describe[1] recent characterization processes of polymers.
CO4	Explain[2] the Polymer Solution and discuss the structure, properties and application of the polymers

Syllabus (Theory)

Units	Description	Hours
I	**Introduction to Macromolecular Chemistry**: Importance, basic concepts, raw materials for polymers, concept of functionality, comparison of chain and step-growth, constitution of polymers, homopolymers and copolymers, polymer architectures (graft copolymers, star-branched, hyperbranched and dendrimers), configuration and conformation of polymers, coil formation, mobility in polymers, glass temperature, rubber elasticity, molecular weight distribution, energetics of polyreactions, examples of polymerization reactions (polyadditions, polycondensations)	15
II	**Basic polymer Synthesis**: Chain-growth polymerizations: radical, anionic, cationic, Ziegler/Natta, ring opening. This involves 'living' methods (group transfer polymerization, nitroxide-mediated free radical polymerization, and atom transfer radical polymerization), mechanistic details, kinetics, recent developments and important examples. Step-growth polymerizations divided into those which proceed with C-C , C-O and C-N bond formation: Suzuki, Heck, ADMET, Classical polycondensations, mild polycondensations using activating agents, phase-transfer catalyzed interfacial polycondensations. Copolymerization: Copolymer equation, monomer reactivity ratio, recent developments and important examples of copolymers. Techniques of polymerizations: Bulk, solution, suspension and emulsion polymerization techniques, melt polymerization, solid-state polymerization.	15

III **Characterization of polymers**: 15

Introduction, the purpose of characterization, molecular architecture, crystallizing polymers, survey of characterization techniques.
2. Molecular weight determination: End group analysis, VPO, Light scattering Measurements, viscometry, and gel permentation chromatography.
3. Spectroscopic techniques: Fundamentals, experimental and applications to polymers of the following techniques:
UV-visible spectroscopy, IR and Raman spectroscopy, Nuclear Magnetic (proton, carbon), resonance spectroscopy, NMR of polymers in the solid state, two Dimensional NMR spectroscopy, MALDI-TOF, pyrolysis GC-MS.
Determination of molecular weight of polymers (Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.
Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

IV **Polymer Solution** – Criteria for polymer solubility, Solubility parameter, 15

Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.
Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).
Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly (p-phenylene sulphide polypyrrole, polythiophene)].

Reference Books:

1) Billmeyer F. W. Textbook of Polymer Science, John Wiley & Sons Pvt. Ltd.
2) P. Rempp and E. W. Merrill, Polymer Synthesis Huethig and wepf verlag Basesl.
3) E. Schroder, G. Muller and K. F. Arndt, Polymer Characterization, Hanser publishers, Munich.
4) Odian, G. Principles of Polymerization, 4th Ed. Wiley, 2004.
5) Billmeyer, F.W. Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1971.
6) Ghosh, P. Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
7) Lenz, R.W. Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.

CHS 311: Sustainable Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: This is a core course in advanced organic chemistry. This course is a crossover of core principles of designing of organic synthesis and greener/sustainable chemistry concepts. Students will germinate the thoughts by combining their knowledge of chemistry and systems thinking.

Course Outcomes: At the end of this course students will able to

CO1	Define[1] concept of sustainable chemistry.
CO2	Discuss[2] the concept of Sustainability remedial measures for minimization of waste.
CO3	Describe[2] the prevention of chemical accidents and designing greener processes.
CO4	Apply[2] knowledge of physicochemical principles in manufacturing of important chemicals.
CO5	Demonstrate[3] conceptual understanding of systems thinking.

Syllabus (Theory)

Units	Description	Hours
I	*Introduction to Sustainable Chemistry*: The concept, Myths and facts, Relation of sustainability with green chemistry, recycling, economy and environment. New Technology. *Principles of Green Chemistry and Sustainability*: Introduction: Innovations in green chemistry, Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following: Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy (examples), calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity. Risk = (function) hazard × exposure; waste or pollution prevention hierarchy. Green solvents how to compare greenness of solvents. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.	15
II	*Trends in Sustainable Chemistry*: All it begins at knowledge of atoms and periodic table. Concept of Circular economy, Systems thinking, Concept of Toxicology, Concept of Sustainability: Requirements for sustainability, Cradle to cradle, Environment foot print, Life cycle assessment. Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.	15

III	*Trends in Sustainable Chemistry*: Design of experiment concept, Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis. Prevention of chemical accidents & designing greener processes, inherent safer design (ISD), principle of ISD, Greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.	15
IV	*Examples of Green Synthesis/ Reactions and some real-world cases*: *Green Synthesis of the following compounds*: Adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). *Microwave assisted reactions in water*: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction. *Ultrasound assisted reactions*: Sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine). *Surfactants for carbon dioxide*: Replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.. *Healthier fats and oil* : Enzymatic interesterification for production of no Trans-Fats and Oils. *Development of Fully Recyclable Carpet*: Cradle to Cradle Carpeting	15

Reference Books

1. Anastas, P. T. and Warner J. C, Green Chemistry: Theory and Practice: New York Oxford University Press.
2. Anastas, P. T., Green Chemistry: Frontier in Design Chemical synthesis and Process: C. Williamson New York.
3. Ahluwalia V. K., Green Chemistry, Ane Books Pvt. Ltd.

E resources

1. www.beyondbenign.com
2. Bakshi B R, Gutowski T G, Sekulic D P Claiming Sustanability: Requirements and Challenges, *ACS Sustainable Chem Eng* 2018, 6, 3632.
3. Reichmanis E, Sabahi M, Life Cycle Inventory Assessment as Chemistry & Engineering Education Tool *ACS Sustainable Chem Eng* 2017, 5, 9603.

----------Skill Enhancement Courses (Chemistry) (Credit: 02 each) ----------

CHS 313: Pharmaceutical Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
2	-	-	2	Theory	FET	20	40	40
					CAT-I	30		
					ESE	50	40	

Course description: It is a skill enhancement course in Chemistry and introduces methods to reduce generation of waste. It covers fundamental concepts of green chemistry for drugs & pharmaceuticals synthesis.

Course Outcomes: At the end of this course students will able to

CO1	Discuss[2] chemistry of drugs & pharmaceuticals.
CO2	Describe[1] types, properties and aerobic and anaerobic fermentation process for the synthesis of drugs & pharmaceuticals.
CO3	Demonstrate[3] conceptual understanding of Toxicology.

Syllabus (Theory)

Units	Description	Hours
I	*Introduction to Drugs***:** Nomenclature, Pharmacophore, Prodrug, Half – life efficiency, Concept of Toxicology: Chirality, Design for biodegradability, Electrophilic reactions and Hazard evaluation, LD 50, ED 50, Therapeutic Index. Receptors, Drug – receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction. *Drugs & Pharmaceuticals*: Drug discovery, design and development; Basic Retrosynthetic approach. Introduction of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol);	15
II	*Introduction of the representative drugs of the following classes*: antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim). Antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine). *Fermentation*: Aerobic and anaerobic fermentation. Production of Ethyl alcohol and citric acid, Penicillin.	15

Text Book:

1. Block J H, Beale J M, Wilson & Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams & Wilkins.

Reference Books:

1. Patrick G.L. Introduction to Medicinal Chemistry, Oxford University Press, UK. 65 Hakishan,
2. Kapoor V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi.
3. William O. Foye, Thomas L., Lemke, David A. William: Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi

E resource

1. Concept of toxicology: www.beyondbenign.com

CHS 315: Mathematics for Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
2	-	-	2	Theory	FET	20	40	40
					CAT-I	30		
					ESE	50	40	

Course description: This course is at final year of BSc and deals with basic mathematical concepts required for chemistry students.

Course Outcomes: At the end of this course students will able to

CO1	Explain[1] basic concepts of mathematics used for learning chemistry.
CO2	Use[3] mathematical tools to solve equations in chemistry.
CO3	Apply[3] mathematical knowledge in chemistry

Syllabus (Theory)

Units	Description	Hours
I	**Partial fraction:** Introduction, Polynomial, Rational fractions, Proper and Improper fractions, Partial fraction, Resolving into Partial fraction, Application of Partial Fraction in Chemical Kinetics and Pharmacokinetics. **Logarithms:** Introduction, Definition, Theorems/Properties of logarithms, Common logarithms, Characteristic and Mantissa, worked examples, application of logarithm to solve pharmaceutical problems. **Function:** Real Valued function, Classification of real valued functions. **Limits and continuity**: Introduction, Limit of a function, Definition of limit of a function ($\varepsilon - \delta$ definition). **Calculus:** Introductions, Derivative of a function, Derivative of a constant, Derivative of a product of a constant and a function , Derivative of the sum or difference of two functions, Derivative of the product of two functions (product formula), Derivative of the quotient of two functions (Quotient formula) – Without Proof, Derivative of x^n *w.r.t x*, where *n* is any rational number, Derivative of e^x, Derivative of $\log_e x$, Derivative of a^x, Derivative of trigonometric functions from first principles (without Proof), Successive Differentiation, Conditions for a function to be a maximum or a minimum at a point. Application**.**	15
II	**Analytical Geometry:** **Introduction:** Signs of the Coordinates, Distance formula, **Straight Line :** Slope or gradient of a straight line, Conditions for parallelism and perpendicularity of two lines, Slope of a line joining two points, Slope – intercept form of a straight line **Integration:** Introduction, Definition, Standard formulae, Rules of integration, Method of substitution, Method of Partial fractions, Integration by parts, definite integrals, application **Differential Equations :** Some basic definitions, Order and degree, Equations in	15

separable form, Homogeneous equations, Linear Differential equations, Exact equations, Application in solving Pharmacokinetic equations

Laplace Transform: Introduction, Definition, Properties of Laplace transform, Laplace Transforms of elementary functions, Inverse Laplace transforms, Laplace transform of derivatives, Application to solve Linear differential equations, Application in solving Chemical kinetics and Pharmacokinetics equations

Reference Books:

1. Allan Cunningham and Rory Whelan, Maths for Chemists, University of Birmingham, University of Leeds, 2014. (Online Link: https://www.birmingham.ac.uk/Documents/college-eps/college/stem/Student Summer- Education-Internships/Maths-for-Chemists-Booklet.pdf).
2. Adrignola and et. al., Mathematics for Chemistry, March 18, 2013. (Online Link: https://upload.wikimedia.org/wikipedia/commons/9/94/Mathematics_for_Chemistry.pdf).

CHS 317: Organic Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course is at odd semester of third year of B.Sc. It is a foundation course in organic chemistry laboratory and it covers learning of basic skills of organic preparations and separation technique.

Course Outcomes: At the end of this course students will able to

CO1	Recognize[1] organic preparations.
CO2	Identify[1] and separate the organic compound binary mixture.
CO3	Explain[2] estimation of organic compound

Syllabus (Practical)

S.N.	Description
1	**Organic Preparations** 1. Diels-Alder reaction between anthracene and maleic anhydride 2. Reduction: nitrobenzene to azobenzene (TLC of the mixture), m-dinitrobenzene to m-nitroaniline 3. S-benzylisothiuranum salts of any one water soluble and one water insoluble acid: acetic acid, phenyl acetic acid, oxalic acid, benzoic acid, phthalic acid 4. Photochemical reduction of benzophenone to benzopinacol 5. Benzoin condensation of benzaldehyde (using thiamine hydrochloride) 6. Condensation of p-toluidine with benzaldehyde/salicylaldehyde/2-hydroxy-3-methoxy benzadehyde to get Schiff's base (solventless condensation) 7. Knoevenagel condensation in solvent free conditions. 8. Synthesis of isoniazide.
2	**Organic Binary mixture separations**: Solid-Solid, Liquid-Solid, Liquid-Liquid.

Reference Books:

1) Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
2) Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3) Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4) Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5) Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6) Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis,Cengage Learning India Ed.
7) Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8) Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

CHS 319: Inorganic Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course is at odd semester of third year of B. Sc. It is a foundation course in inorganic chemistry laboratory and it covers learning of basic skills of estimation of metals by complexometry, argentometry and colorimetric method. The practical course consists to apply the principles of separations of transition metals, and their estimation from ore.

Course Outcomes: At the end of this course students will able to,

CO1	Understand[2] and apply[3] the concept of complexometric titration, and argentometry.
CO2	Apply[3] principles of colorimetry for the estimation the metals.
CO3	Understand[2] preparation of inorganic complexes and concept of Ion exchange chromatographic method for separations of transition metals.
CO4	Apply[3] Gravimetric and volumetric titrations method for analysis.

Syllabus (Practical)

S.N.	Description
1	**Complexometric Titrations:** (i) Estimation of Zn using potassium ferrocynide. (ii) Estimation of Ca/Mg in drugs and Biological samples.
2	**Argentometry: Estimation** of Cl^- (i) By Mohr's method, (ii) By Vohlard's method.
3	**Colorimetric estimation** of Ni (II), Co (II) and Cu (II).
4	**Ion exchange chromatographic** separations of transition metals.
5	**Gravimetric Estimations: Iron as a ferric oxide,** Zinc as a zinc pyrophosphate and Barium as a barium sulphate.
6	**Preparations:** i) Potassium trioxalato ferrate (III) ii) Hexammine nickel (II) chloride iii) Sodium cuprous thiosulphate
7	**Titrimetric Estimations:** i)Titrable acidity of Milk/Lassi ii) % Purity of ferrous ammonium sulphate

Reference Books:

1) Gilati S.; Sharma, J. L.; Manocha, S. Practical Inorganic Chemistry, CBS Publishers, New Delhi.
2) Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
3) Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4) Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5) Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

CHS 321: Analytical Methods in Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description:
Students perform the experiments on solvent extraction, chromatography and soil analysis.

Course Outcomes: At the end of this course students will able to

CO1	Students apply[3] the knowledge of chromatography for the separation of metal ions from solution.
CO2	Student's apply[3] theory and principles of solvent extraction for metallurgical sample analysis.
CO3	Student's apply[3] the principles of ion exchange to study the compositions of organic and inorganic solution mixtures.
CO4	Student's understand[2] applications of spectroscopy.

Syllabus (Practical)

S.N.	Description
1	**Separation Techniques** **Chromatography**: (a) Separation of mixtures (i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}. (ii) Separation and identification of the monosaccharides present in the given Mixture (glucose & fructose) by paper chromatography. Reporting the Rf. Values. (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values (5 binary mixtures). (c) Chromatographic separation of the major active ingredients of plants, flowers and juices.
2	**Solvent Extractions:** (i) To separate a mixture of Ni $^{2+}$ & Fe^{2+} by complexation with DMG and extracting the Ni^{+2}-DMG complex in chloroform, and determine its concentration by spectrophotometry. (ii) Solvent extraction of zirconium, separation from a mixture of iron and gallium.
3	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
4	Determination of Na, Ca, and Li in cola drinks and fruit juices using flame photometric techniques.
5	**Ion exchange**: (i) Determination of exchange capacity of cation exchange resins and anion exchange resins. (ii) Separation of metal ions from their binary mixture. (iii) Separation of amino acids from organic acids by ion exchange chromatography.
4	**Spectrophotometr**y 1. Determination of pKa values of indicator using spectrophotometry. 2 Structural characterizations of compounds by infrared spectroscopy.

3 Determination of dissolved oxygen in water.
4 Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Text Books

01 Gurtu J N and Gurtu Amit, Advanced Physical Chemistry Experiments, A Publication of Pragati Prakashan, Meerut.

02 Vogel A I, Quantitative Inorganic Analysis including Elementary Instrumental Analysis,3rd Ed. ELBS (1964)

Reference Books

01 Welcher F J,Standard methods of chemical analysis.

02 Findley, A Practical Physical Chemistry,

03 Jahagirdar D V, Experiments in chemistry, Himalaya publications.

04 Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis,(5th edition Revised Copy) Longmann Scientific and Technical jointly with John Wiley and Sons Inc.(PDF soft Copy available free on internet)

05 Willard H H, Meritt L L, Dean J A and Settle F A, Instrumental methods of Analysis. Wadsworth Pub Co;

06 Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

07 Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

08 Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

CHS 323: Chemistry of Material Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description:

Course is specially skill based where students acquire laboratory training on preparation of smart materials required for device applications.

Course Outcomes: At the end of this course students will able to

CO1	Students acquire laboratory skill[4] on preparation of inorganic metal nanoparticles.
CO2	Students acquire laboratory skill[4] on preparation of organic nanoparticles.
CO3	Student's undertake[2] laboratory experiments to study mechanical and corrosion behavior of engineering materials of construction.
CO4	Student's undertake[2] laboratory experiments to prepare doped and conjugated materials required for device applications.

Syllabus (Practical)

S.N.	Description
1	**Preparation and characterization of inorganic nanoparticles:** i) Synthesis of hydrogel by co-precipitation method and characterization. ii) Synthesis of silver and gold metal nanoparticles and characterization.
2	**Preparation and characterization of organic nanoparticles:** i) Preparation of fluorescent perylene nanoparticles by reprecipitation method and characterization by absorption spectroscopy. ii) Preparation of fluorescent pyrene nanoparticles by reprecipitation method and characterization by absorption spectroscopy.
3	**Engineering Materials:** i) Verification of Hooke's law graphically. ii) Study of Pourbaix diagram by measuring redox potential of Fe^{3+}/Fe^{2+} at different pH of electrolytic solutions.
4	**Doped organic and conjugated inorganic materials:** i) Preparation and characterization doped fluorescent organic semiconducting materials ii) Preparation and characterization of metal oxinates for fluorescence studies.

Text Books

01 Poole, C.P. & Owens, F.J. Introduction to Nanotechnology John Wiley & Sons, 2003.

02 Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry. John Wiley & Sons, 1974.

Reference Books

01 Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, 32

02 Gary D Christian, Analytical Chemistry 6^{th} edition, John Willey and Sons(2003)

03 Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

04 Fahlman, B.D. Materials Chemistry, Springer, 2004.

CHS 325: Polymer Science & Technology Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course help students to acquire skills related to synthesis and characterization of polymer compounds.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] synthesis of polymer compounds.
CO2	Describe[1] properties of polymer compounds.
CO3	Apply[2] characterization techniques for analysis of polymers.
CO4	

Syllabus (Practical)

S.N.	Description
1	**Polymer synthesis** 1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA). a. Purification of monomer b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN) 2. Preparation of nylon 66/6 1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein a. Preparation of IPC b. Purification of IPC c. Interfacial polymerization 3. Redox polymerization of acrylamide 4. Precipitation polymerization of acrylonitrile 5. Preparation of urea-formaldehyde resin 6. Preparations of novalac resin/resold resin. 7. Microscale Emulsion Polymerization of Poly-(methylacrylate).

2 Polymer characterization

1. Determination of molecular weight by viscometry:
(a) Polyacrylamide-aq. $NaNO_2$ solution
(b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly (vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

3 Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

Reference Books:

1) M.P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, 1999.
2) H.R. Allcock, F.W. Lampe & J.E. Mark, Contemporary Polymer Chemistry, 3rd ed.Prentice-Hall (2003)
3) F.W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
4) J.R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
5) P. Munk & T.M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
6) L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
7) M.P. Stevens, Polymer Chemistry: An Introduction 3rd ed. Oxford University Press (2005).
8) Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

CHS 327: Sustainable Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course covers aspects of green chemistry for sustainable chemistry.. This course covers learning of techniques of use of safer starting materials and renewable resources and alternative Green solvents for synthesis of organic compounds.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] safer starting materials and renewable resources for synthesis of nanoparticles and their use in organic transformations
CO2	Describe[2] an enzyme catalysis.
CO3	Explain[2] the chemistry of alternative Green solvents in organic synthesis.
CO4	Apply[2] knowledge of chemistry for alternative sources of energy.

Syllabus (Practical)

S.N. **Description**

1 Safer starting materials

Preparation and characterization of nanoparticles of gold using tea leaves.

2 Using renewable resources

Preparation of biodiesel from vegetable/ waste cooking oil.

3 Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

- Click reaction
- Michael addition reaction

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH- → propene + trimethylpropene + water

(II) 1-propanol H2SO4/Δ → propene + water

Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4 Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5 Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.

Mechanochemical solvent free synthesis of azomethines

6 Alternative sources of energy

Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of Copper (II). Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

1) Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
2) Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
3) Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4) Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment:A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN, 978-93-81141-55-7 (2013).
5) Cann, M.C. & Connelly, M. E. Real world cases in Green Chemistry, American Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
6) Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.
7) Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach, W.B.Saunders, 1995.Chemical Society (2008).

CHS 329: Pharmaceutical Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min. Pass (%)	
-	-	2	1	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course help student to acquire skills of isolation and preparation of pharmaceutical compounds.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] Preparation of pharmaceutical compounds and its
CO2	Discuss[2] kinetic and properties of pharmaceutical compounds.
CO3	Describe[2] properties and synthesis of carbohydrates.
CO4	Describe[1] types, properties and synthesis of dyes.

Syllabus (Practical)

S.N.	Description
1	Lettuce seed assay.
2	Daphnia Bioassay
3	Preparation of Aspirin and its analysis.
4	Preparation of magnesium bisilicate (Antacid).
5	Preparation of Acetanilide.
6	Preparation of Barbutiric Acid.
7	Preparation of Phenyl Azo β-naphthol.
8	Determination of reaction rate constant first order.
9	Determination of viscosity of liquid using Ostwald's viscometer.
10	Determination of particle size, particle size distribution using sieving method.
11	Analysis of crude drugs by chemical tests: (i)Tragacanth (ii) Acacia (iii)Agar (iv) Gelatin (v) starch (vi) Honey (vii) Castor oil.
12	Preparation and standardization of EDTA solution, at least one exercise related to pharmacopoeial assays by complexometric titration.

Reference Books:

1. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK. 65.
2. Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi

E resources

4. Concept of toxicology: www.beyondbenign.com

CHS 331: Mathematics for Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min. Pass (%)	
-	-	2	1	Practical	FEP	50	40	40
					POE	50	40	

Course description:

Course Outcomes: At the end of this course students will able to

CO1	Use[3] mathematical tools in chemical calculations.
CO2	Use[3]computational tools for prediction of chemical properties.

Syllabus (Practical)

S.N.	Description
1	To sketch the polar plot of 's' and 'p' orbitals.
2	To plot the graph of following function using Excel a) Exponential function b) Logarithmic function c) Linear function
3	To plot the graph by using origin software.
4	Use of Computer - Chem Draw, Chem-Sketch, ISI – Draw: (One practical) Draw the structure of simple aliphatic, aromatic, heterocyclic compounds with Different substituents. Get the correct IUPAC name and predict the IR, $H^1$and C^{13}NMR signals.

Text Books:

1. Adav, Pol. et. al. Practical Chemistry, Manali Prakashan, Pune-30, June2013.

Reference Books:

1. A. I. Vogel, A textbook of Practical Organic Chemistry.

2. H. Middleton, Systematic Qualitative analysis.

3. H. T. Clark, A handbook of Organic Analysis Qualitative and Quantative.

4. F.G. Mann and B.C. Saunders, Practical Organic Chemistry.

CHS 333: Mini Project Phase-I

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	WT	Pass
-	-	4	2	Practical	TW	50	Min 40
					ESE	50	

Steps Involved in Project

S.N.	Description
1	**Project:** This may involve following stages: Research / Project interests from student will be collected. A departmental committee will evaluate research interests and based on faculty competency, project supervisor will be allotted. It may involve Literature survey and Definition of Problem, Proposing Hypothesis, Designing Experiments, Testing hypothesis and confirming results, Interpretation and Reporting Results.
2.	In the middle of semester there will be evaluation of progress. At the end of each semester the Students will present results and presentation will be evaluated.

Semester-VI

CHS 302: Physical Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: The course is devoted to the obtaining the knowledge on light induced physical and chemical processes and their kinetic studies. T
he course also includes understanding of the enzymatic and non-enzymatic catalyzed reactions. Students will be introduced into basics of quantum chemistry and nuclear chemistry.

Course Outcomes: At the end of this course students will able to

CO1	Understand[2] basics of light induced reactions.
CO2	Understand[3] methods of determination of rates of reactions and elucidate the mechanism of industrially and environmentally important reactions.
CO3	Understand[2] basics of quantum chemistry.
CO4	Understand[2] basic principles of radiochemistry and radioactive disintegration processes and their applications.

Syllabus (Theory)

Units	Description	Hours
I	**Photochemistry:** Introduction: Absorption of light, Laws of Photochemistry, quantum yield of photochemical reactions, actinometry, examples of low and high quantum yields, Studies of some photochemical reactions: photodissociation of HI and photochemical chain reactions, photosensitized reactions, **Photophysical Phenomenon:** Introduction: Fluorescence, phosphoresce and chemiluminoscence; Basic principle and mechanism. **Photochemistry of Environment:** Introduction: Formation and dissociation of ozone in the environment, formation of smog and acid rain, greenhouse gases, depletion of ozone layer and greenhouse effect. (Numerical problems on photochemistry).	15
II	**Chemical Kinetics:** Order and molecularity of a reaction, rate laws, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy.	15

(Numerical.)

III **Electromotive Force (EMF):** 15

Introduction: Galvanic cells, Reversible electrodes, Thermodynamics of reversible electrodes and cells. Nernst equation, Standard electrode potential: The electrochemical series.
Concentration cells: Electrode-concentration cells, Electrolyte-concentration cells.
Types of electrolytic concentration cells: Concentration cell without transference, concentration cell with transference.
Liquid-Junction Potential, Fuel Cells, Applications of EMF measurements.
(Numerical).

IV **Nuclear Chemistry**: **Radioactivity**: 15

Discovery, Types of radioactive decay, Decay schemes, General characteristics of radioactive decays, decay kinetics, units of radioactivity, problem solving on decay kinetics. Bethe's notation, Types of nuclear reactions, Conservation of nuclear reactions (Conservation of protons and neutrons, Conservation of momentum and energy), The compound nucleus theory, Calculations of excitation energy of compound nucleus, Photonuclear reactions, Thermonuclear reactions. (Numerical)

Text Books

01 Gurudeep Raj, Advanced Physical Chemistry, Goel Publishing House;
Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

Reference Books

01 Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
02 Ball, D. W. Physical Chemistry Thomson Press, India (2007).
03 David Harvey, Modern Analytical Chemistry, McGraw Hill Publication, International Edition available as e-book.(www.mhhe.com)
04 Laidler, K. J. Chemical Kinetics Pearson Education: New Delhi (2004).
05 Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
06 Essentials of Nuclear Chemistry by H. J. Arnikar, 4th Revised Edition, New Age International Publishers.
07 Garen W. Ewing, Analytical Instrumentation, Handbook, Marcel Dekker Inc. (1997).
08 Glasstone Samuel, Source book of Atomic energy, 3rd edition, East -West press.
09 Winefordner J, Schulman S and Haver, T O, Luminescence Spectrometry in Analytical Chemistry, WielyInterscience, New York.
10 Skoog D A, West D M, Fundamentals of Analytical Chemistry (Holt Rinehart and Winston Inc.).
11 Overman and Cleark, Radioisotopes techniques, MGH.
12 Ruzica and Stary, Substopchiometry in Radiochemical Analysis. Pergamon.
13 Friedlander G, Kennedy J W, Nuclear and Radiochemistry, Wiley.
14 Price W J, Nuclear radiation detections, McGraw Hill New York.
15 Gurtu J N and Gurtu Amit, Advanced Physical Chemistry Experiments, A Publication of Pragati Prakashan, Meerut.

CHS 304: Analytical Chemistry (Spectroscopy)

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: This is a core course in advanced organic chemistry. This course introduces the concept of spectroscopy, interpretation of spectrum, and use of combination of spectroscopic methods for elucidation of structure of organic molecules.

Course Outcomes: At the end of this course students will able to

CO1	Describe[1] instrumentation in spectroscopy.
CO2	Explain[2] basic concepts involved in spectroscopic techniques.
CO3	Interprete[3] the spectrum.
CO4	Describe[1] basic principles of mass Spectroscopy.
CO5	Apply[3] basic knowledge of spectroscopy for structure identification.

Syllabus (Theory)

Units	Description	Hours
I	General principles, electromagnetic radiations, concept of scpectyroscopy, absorption and emission spectroscopy. ***UV Spectroscopy*:** Basic principles, Beer-Lambert law, instrumentation, types of absorption bands, Factors affecting the positions of UV bands Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers. Problems.	15
II	***IR Spectroscopy*:** Basic principle, Fundamental and non-fundamental molecular vibrations; Hook's law, instrumentation, IR absorption positions of O, N and S containing functional groups; Effect of H- bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis. Interpretation of IR spectrum.	15
III	***NMR Spectroscopy***: Basic principles of Proton Magnetic Resonance, instrumentation, concept of chemical shift and factors influencing it; spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, ^{13}C NMR spectroscopy, interpretation of NMR spectra of simple compounds.	15

IV	***Mass spectroscopy*:** Basic concept, instrumentation: components of mass spectrometer, inlet system Ion source accelerating system magnetic field ion separator, ion collector, vacuum system, types of ions produced rules of interpretation of mass spectra. McCafferty rearrangement. Applications of IR, UV, NMR and mass spectroscopy for identification of simple organic molecules.	15

Text Books:

1. Sharma, Y. R. Elementary Organic Spectroscopy, S. Chand and Company Ltd.

Reference Books:

1. Pavia, D. L., Lampman, G. M., Kriz, G. S., Vyvyan J. R. Introduction to Spectroscopy, Cengage Learning Pvt. Ltd.
2. Field, L. D. Organic Structures from Spectra, J Wiley & Sons Ltd.
3. Kalsi P.S. Spectroscopy of Organic compounds, New age publishing.
4. Kemp, W. Organic spectroscopy ELBS.

----------Discipline Specific Electives Sem-VI----------

CHS 306: Utility of Industrial Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: This course covers core principles of air and water and nuclear pollution and its analysis and purification treatments methods.

Course Outcomes: At the end of this course students will able to

CO1	Describe[2] Industrial Gases and Inorganic Chemicals and General Principles of Metallurgy.
CO2	Describe[1] air pollutants and its effect on Global warming and Ozone depletion.
CO3	Explain[1] water pollution and its treatment for purification to improve the water quality parameters
CO4	Discuss[2] energy & environment, Nuclear Pollution and biocatalysis

Syllabus (Theory)

Units	Description	Hours
I	**Industrial Gases and Inorganic Chemicals** Industrial Gases: Large scale production uses storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate. **Industrial Metallurgy** **General Principles of Metallurgy** Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process. Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.	15
II	**Environment and its segments** Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. **Air Pollution**: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere.	15

Air pollutants: types, sources, particle size and chemical nature; Photochemical **smog:** its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

III **Water Pollution:** Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. 15

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

IV **Energy & Environment** 15

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Reference Books:

1) E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2) R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3) J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
4) S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
5) K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
6) S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
7) S.E. Manahan, Environmental Chemistry, CRC Press (2005).
8) G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9) A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

CHS 308: Chemical Products of Industrial Relevance

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: This course help student to acquire skills related to the types, characteristic properties of glass, ceramics, cements and fertilizers, paints and pigments, alloys, sensors and chemical explosives analysis.

Course Outcomes: At the end of this course students will able to

CO1	Discribe[2] the types and the properties glass.
CO2	Discribe[2] the characteristic properties of ceramics, cements and fertilizers.
CO3	Explain[3] the chemistry of paints and pigments and introduction and working of batteries.
CO4	Discribe[2] types, classification, characteristics and properties of alloys, sensors and chemical explosives.

Syllabus (Theory)

Units	Description	Hours
I	**Silicate Industries** **Glass**: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses **Glasses**: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, Fluorosilicate, coloured glass, photosensitive glass.	15
II	**Ceramics:** Important clays and feldspar, ceramic, their types and manufacture. High Technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre. **Cements:** Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements. **Fertilizers:** Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.	15
III	**Surface Coatings:** Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly	15

paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Batteries:

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

IV **Alloys:** 15

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Sensors:

Introduction, Principles, Classification, Characteristics: Static and Dynamic, Characterization, Account of Mechanical and Electromechanical, Thermal, Magnetic, Radiation, Electroanalytical, Smart sensors, Application of sensors.

Chemical explosives:

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Reference Books:

1) E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2) R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3) W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4) Patranabis, D. Sensoprs and Transducers, Prentice Hall of India Pvt. Ltd. New Delhi.
5) J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
6) P. C. Jain & M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
7) R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
8) B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

CHS 310: Instrumental Methods of Chemical Analysis

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: This course help student to acquire skills related to all chromatographic and spectroscopic techniques, electroanalytical and radiochemical methods and surface analysis techniques for analysis.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] Infrared spectroscopy techniques for analysis.
CO2	Discuss[1] UV-Visible/Near IR spectroscopy techniques for analysis.
CO3	Explain[2] chromatography separation techniques and mass spectroscopy techniques for analysis.
CO4	Discuss[1] NMR spectroscopy, electroanalytical and radiochemical methods and surface analysis techniques.

Syllabus (Theory)

Units	Description	Hours
I	**Introduction to spectroscopic methods of analysis:** Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation. **Molecular spectroscopy:** **Infrared spectroscopy:** Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.	15
II	**UV-Visible/ Near IR** – emission, absorption, fluorescence and photo-acoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photo-acoustic, fluorescent tags). **Elemental analysis:**	15

Mass spectrometry (electrical discharges).
Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

III **Separation techniques** 15

C**hromatography:** Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Immunoassays and DNA techniques

Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

IV **NMR spectroscopy**: **P**rinciple, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications. 15

Electroanalytical Methods: Potentiometry & Voltammetry

Radiochemical Methods,

X-ray analysis and electron spectroscopy (surface analysis)

Reference Books:

1) Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
2) Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3) P.W. Atkins: Physical Chemistry.
4) G.W. Castellan: Physical Chemistry.
5) C.N. Banwell: Fundamentals of Molecular Spectroscopy.
6) Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7) W.J. Moore: Physical Chemistry.

CHS 312: Molecules of Life

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
4	-	-	4	Theory	FET	20	40	40
					CAT-I	15		
					CAT-II	15		
					ESE	50	40	

Course description: This course covers learning of chemistry of carbohydrates, peptides, proteins, nucleic acids, lipids, biological activity of enzymes and correlation with drug action.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] chemistry of carbohydrates, peptides, proteins.
CO2	Describe[2] chemistry of nucleic acids.
CO3	Recognize[1] biological activity of enzymes and correlation with drug action.
CO4	Predict[2] activity of lipids and concept of energy in biosystems.

Syllabus (Theory)

Units	Description	Hours
I	**Carbohydrates (10 Periods)** Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation. **Amino Acids, Peptides and Proteins (12 Periods)** Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (tbutyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.	15
II	**Enzymes and correlation with drug action (12 Periods)** Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Noncompetitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring,	15

III **Unit 4: Nucleic Acids (10 Periods)** 15

Components of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature**), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

IV **Lipids** 15

Introduction to lipids, classification.
Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.
Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Concept of Energy in Bio systems

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change.
Conversion of food into energy. Outline of catabolic pathways of Carbohydrate-Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Reference Books:

1) Graham Solomons, T. W. Organic Chemistry, John Wiley & Sons Pvt. Ltd.
2) Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3) Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4) Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5) Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
6) Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.

Skill Enhancement Courses (Chemistry) (Credit: 02 each)

CHS 314: Pesticide Chemistry

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
2	-	-	2	Theory	FET	20	40	40
					CAT-I	30		
					ESE	50	40	

Course description: This course help student to acquire skills for the synthesis, estimation and analysis of pesticides.

Course Outcomes: At the end of this course students will able to

CO1	Describe[2] introduction to pesticides.
CO2	Describe[1] types, properties and synthesis of pesticides.

Syllabus (Theory)

Units	Description	Hours
I	General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship. Class as per chemistry and as per application; Insecticides, fungicides, herbicides, rodenticides, International pesticide market size, Importance of herbicides in the international market; Indian pesticide market ; Importance of insecticides in Indian market; Pesticide usage per hectare in India as against in other countries.	15
II	Synthesis and technical manufacturing and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).	15

Reference Books:

1) Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978

CHS 316: Chemistry of Cosmetics and Perfumes

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
2	-	-	2	Theory	FET	20	40	40
					CAT-I	30		
					ESE	50	40	

Course description: This course help student to acquire skills for the preparation and uses of cosmetics and perfumes and essential oils.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] preparation and uses cosmetics and perfumes.
CO2	Describe[1] chemistry and the importance of Essential oils.
CO3	Demonstrate[3] understanding of process in perfumery industry.

Syllabus (Theory)

Units	Description	Hours
I	Introduction to Cosmetics, Definition, Characteristics, Formulations: A general study including preparation and uses of the following: Toothpaste, Powders, Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.	15
II	Introduction to Perfumery, IP and Industrial outlook, Synthetic approach: Homogeneous, Heterogeneous and Biocatalytic routes. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, Rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	15

Textbooks:

1. Sharma, G. K., Gadiya, J. Dhanawat, M. Textbook of Cosmetics Formulations.

Reference Books:

1. Joshi S. S., Ranade V. V. Industrial Catalytic Processes for Fine and Specialty Chemicals; Elsevier, ISBN: 9780128014578.
2. Stocchi E. : Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
3. Jain, P.C. M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
4. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

CHS 318: Physical Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: The practical course consists to apply the principles of absorption spectroscopy, optical activity and chemical kinetics at laboratory scale to evaluate the molecular constant and fate of physical and chemical reactions.

Course Outcomes: At the end of this course students will able to

CO1	Student's apply[3] principles of colorimetry to study the physical reactions.
CO2	Student's understand[2] method of evaluation of bond length and bond energy of diatomic molecule.
CO3	Students[2] evaluate effect of temperature on the chemical reactions.
CO4	Student's apply[3] optical activity technique for industrial reaction inversion of cane sugar.

Syllabus (Practical)

S.N. **Description**

1 Colorimetry:

i) Verification of Lambert-Beer's Law
ii) Determination of pK (indicator) of phenolphthalein colorimetrically.
iii) Study the formation constant of ferric sulphosalicylic acid spectrophotometrically.
iv) Study the kinetics of interaction of crystal violet with sodium hydroxide colorimetrically.
v) Studies on UV spectrum of p-nitrophenol in ethanol-water mixture (1:4). Find out effect of addition of sodium hydroxide crystal on the absorption spectrum.
vi) Measure the UV-spectrum of a acetone in acetone in cyclohexane.

2 Vibration-Rotation Spectroscopy:

Analysis of the given vibration-rotation spectrum of HCl(g)

Conductometry:

Determination of solubility and solubility product of sparingly soluble salt by conductance measurements.

3 Chemical Kinetics:

Determine the temperature coefficient of the reaction between potassium per sulphate and potassium iodide.

4 Polarimetry:

Determination of rate constant of inversion of cane sugar by polarimetry.

Text Books

01 Gurtu J N and Gurtu Amit, Advanced Physical Chemistry Experiments, A Publication of Pragati Prakashan, Meerut.

02 Vogel A I, Quantitative Inorganic Analysis including Elementary Instrumental Analysis,3rd Ed. ELBS (1964)

Reference Books

01 Welcher F J,Standard methods of chemical analysis.

02 Findley, A Practical Physical Chemistry,

03 Jahagirdar D V, Experiments in chemistry, Himalaya publications.

04 Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis,(5th edition Revised Copy) Longmann Scientific and Technical jointly with John Wiley and Sons Inc.(PDF soft Copy available free on internet)

05 Willard H H, Meritt L L, Dean J A and Settle F A, Instrumental methods of Analysis. Wadsworth Pub Co;

CHS 320: Analytical Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description:

Course consists of analysis concerned to agriculture, pharmacy and metallurgical industry. Students can perform the analysis collecting the soil, water and alloy samples from local region and medicines from local market.

Course Outcomes: At the end of this course students will able to

CO1	Apply[3] their knowledge of Beer's law to determine unknown concentration.
CO2	Understand[3] mole and molarity concepts using absorption spectroscopy.
CO3	Find[3] structure of compounds using IR and NMR spectrum.

Syllabus (Practical)

S.N.	Description
1	Introduction to Spectroscopy (pre laboratory questions will be given): determination of λmax.
2	Determination of an unknown concentration Cu/Mg salt solution using Beer's law
3	Identification of relation between color and wavelength of light absorbed.
4	Identification of relation between absorbance and concentration.
5	Spectrophotometric determination of caffein and benzoic acid in soft drink.
6	Analysis of IR and NMR spectrum to identify structure of compounds.
7	Analysis of chloride content from saline sample based on fluorescence quenching studies using Quinine sulphate probe.

Reference Books

1 Willard H H, Meritt L L, Dean J A and Settle F A, Instrumental methods of Analysis. Wadsworth Pub Co

2 Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis,(5th edition Revised Copy) Longmann Scientific and Technical jointly with John Wiley and Sons Inc.(PDF soft Copy available free on internet)

CHS 322: Utility of Industrial Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course help student to acquire skills related to analysis methods for purification of water and air.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] the chemistry of Environmental Pollution.
CO2	Describe[1] estimation of acidity, alkalinity, amount of chlorine, COD and BOD.

Syllabus (Practical)

S.N.	Description
1	Determination of dissolved oxygen in water.
2	Determination of Chemical Oxygen Demand (COD)
3	Determination of Biological Oxygen Demand (BOD)
4	Percentage of available chlorine in bleaching powder.
5	Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO3 and potassium chromate).
6	Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7	Measurement of dissolved CO_2.
8	Study of some of the common bio-indicators of pollution.
9	Estimation of SPM in air samples.
10	Preparation of borax/ boric acid.

Reference Books:

1) E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2) R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3) J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
4) S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
5) K. De, Environmental Chemistry: New Age International Pvt. Ltd, New Delhi.
6) S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

CHS 324: Chemical Product of Industrial Relevance

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course help student to acquire skills related to analysis of ore ally, cement, fertilizer and detergents.

Course Outcomes: At the end of this course students will able to

CO1	Analysis[4] of fertilizer samples.
CO2	Analysis of ore, alloy and cement samples.
CO3	Explain[2] analysis of detergents.
CO4	Explain[1] the preparation of pigments.

Syllabus (Practical)

S.N.	Description
1	Determination of free acidity in ammonium sulphate fertilizer (Electrogravimetry).
2	Estimation of calcium in calcium ammonium nitrate fertilizer (Electrogravimetry).
3	Estimation of phosphoric acid in superphosphate fertilizer (Electrogravimetry).
4	Electroless metallic coatings on ceramic and plastic material.
5	Determination of composition of dolomite (by complexometric titration).
6	Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7	Analysis of Cement
8	Preparation of pigment (zinc oxide).
9	Analysis of detergents.

Reference Books:

1) E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2) R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3) W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4) J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
5) P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
6) R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
7) Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

CHS 326: Instrumental Methods of chemical Analysis Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course covers learning of techniques of separation, purification and identification of mixture of analysis.

Course Outcomes: At the end of this course students will able to

CO1	Discuss UV/Vis and IR absorption spectra in organic molecules.
CO2	Describe the analysis by using GC and HPLC techniques.
CO3	Explain[2] potentiometric titration, cyclic voltametry and nuclear magnetic resonance.
CO4	Explain[2] the use of fluorescence and capillary electrophoresis techniques for analysis.

Syllabus (Practical)

S.N.	Description
1	Safety Practices in the Chemistry Laboratory
2	Determination of the isoelectric pH of a protein.
3	Titration curve of an amino acid.
4	Determination of the void volume of a gel filtration column.
5	Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6	Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7	IR Absorption Spectra (Study of Aldehydes and Ketones)
8	Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9	Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10	Separation of Carbohydrates by HPLC
11	Determination of Caffeine in Beverages by HPLC
12	Potentiometric Titration of a Chloride-Iodide Mixture
13	Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14	Nuclear Magnetic Resonance
15	Use of fluorescence to do “presumptive tests” to identify blood or other body fluids

16 Use of "presumptive tests" for anthrax or cocaine

17 Collection, preservation, and control of blood evidence being used for DNA testing

18 Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)

19 Use of sequencing for the analysis of mitochondrial DNA

20 Laboratory analysis to confirm anthrax or cocaine

21 Detection in the field and confirmation in the laboratory of flammable accelerants or explosives

22 Detection of illegal drugs or steroids in athletes

23 Detection of pollutants or illegal dumping

24 Fiber analysis (**At least 10 experiments to be performed**)

Reference Books:

1) Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
2) Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

CHS 328: Molecules of Life

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	4	2	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course covers learning of techniques of separation, purification and identification of amino acids, oil and fats.

Course Outcomes: At the end of this course students will able to

CO1	Describe[2] Separation of amino acids.
CO2	Recognize[1] biological activity of enzymes.
CO3	Calculate[4] saponification and iodine value of an oil/fat.

Syllabus (Practical)

S.N.	Description
1	Separation of amino acids by paper chromatography
2	To determine the concentration of glycine solution by formylation method.
3	Study of titration curve of glycine
4	Action of salivary amylase on starch
5	Effect of temperature on the action of salivary amylase on starch.
6	To determine the saponification value of an oil/fat.
7	To determine the iodine value of an oil/fat
8	Differentiate between a reducing/ nonreducing sugar.
9	Extraction of DNA from onion/cauliflower
10	To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

Reference Books:

1) Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
2) Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

CHS 330: Pesticide Chemistry Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min. Pass (%)	
-	-	2	1	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course help student to acquire skills for the synthesis, estimation and analysis of pesticides.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] synthesis of pesticides.
CO2	Determine[2] acidity/alkalinity of given pesticides sample.
CO3	Student's apply[3] principles of Nephelometric and Kjeldal's method for the estimation of nitrogen, sulphate and phosphate
CO4	Explain[3] and detect the pesticide residue in plants

Syllabus (Practical)

S.N.	Description
1	To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2	Preparation of simple organophosphates, phosphonates and thiophosphates.
3	Estimation of nitrogen by Kjeldal's method.
4	Nephelometric estimation of sulphate and phosphate.
5	Conductometric analysis of salinity of soil.
6	Determination of acidity of given pesticides sample.
7	Determination fo alkalinity of given pesticide sample.
8	Detection of pesticide residue in plants.

Reference Books:

1) Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978

CHS 332: Chemistry of Cosmetics and Perfumes Lab

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme				
				Component	Exam	WT	Min Pass (%)	
-	-	2	1	Practical	FEP	50	40	40
					POE	50	40	

Course description: This course covers learning of techniques of synthesis of cosmetics and perfumes.

Course Outcomes: At the end of this course students will able to

CO1	Explain[2] preparation of cosmetics and perfumes.
CO2	Apply[3] their knowledge of chemistry in preparation of cosmetics.

Syllabus (Practical)

S.N. **Description**

1. Preparation of talcum powder.
2. Preparation of Dusting powder
3. Preparation of shampoo.
4. Preparation of enamels.
5. Preparation of hair remover.
6. Preparation of face cream.
7. Preparation of nail polish and nail polish remover.
8. Preparation of effervescent granules of Sodium Sulphate (Eno)
9. Preparation of ORS powder

Reference Books:

1) E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2) P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
3) Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, M

CHS 334: Mini Project Phase-II

(Version 1.0, Program Core, School of Sciences)

Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	WT	Pass
-	-	4	2	Practical	TW	50	Min 40
					POE	50	

S.N.	Description
1	**Project:** Based on research interest student will continue work for project under supervision of identified project supervisor. At the end student will submit a project report.
2.	In the middle of semester there will be evaluation of progress. At the end of each semester the Students will present results and presentation will be evaluated.

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