Necessary Information

and

Syllabi of Undergraduate (UG) programs

as per

National Education Policy (NEP) 2020

With effective from 2021-2022 academic session

Faculty of Science

P.K. University

Shivpuri, M.P.

Preamble:

The Govt. of the State of Madhya Pradesh (M.P.) formulated the general guidelines (rules & regulations) through its Ordinance and suggested syllabi through duly constituted Central Board of Studies (CBS) within the framework of National Education Policy (NEP) 2020 for UG programs with effective from the academic session 2021-2022. The guidelines are as per the "Guidelines for Multiple Entry and Exit in Academic Programs offered in Higher Educations Institutions (HEIs)" issued by University Grants Commission (UGC) under the NEP 2020.

The Faculty of Science, P.K. University, offers undergraduate (UG), postgraduate (PG), & Doctoral (Ph.D.) programs through its constituent Departments - Department of Physics, Department of Chemistry, Department of Mathematics, and Department of Bioscience.

The Faculty of Science has adopted them for its all UG programs and will start 4-year UG programs with multiple entry and exit modes from the academic session 2021-2022 as per the directives of the Govt. of the State of M.P. The Faculty of Science will offer the *Certificate*, *Diploma*, *B.Sc.*, and *B.Sc. (Honours/Research)* and will follow the *annual system*.

The necessary information and syllabi of various UG programs of the Faculty of Science are given here.

Necessary information:

1. Admission rules and guidelines for admission to UG programs will be framed by the University for admission in its University Teaching Departments (UTD)/Faculties.

2. Students who have successfully completed Grade 12 School Leaving Certificate from Board of Secondary Education, M.P., Bhopal or an equivalent examination from any other board recognized by the State Government/University will be eligible for admission to the UG programs.

3. The admission shall be made on merit calculated on the basis of criteria notified by the state government/university, as the case may be, keeping in view the guidelines/norms in this regard issued by the UGC and other statutory bodies concerned and taking into account the reservation policy issued by the government from time to time.

4. Student enrolment in a program/course shall be restricted to the seats allotted by the University/State Govt.

5. The in-take capacity shall be determined in advance by the University in accordance with the guidelines/norms in this regard issued by the State Govt./UGC and other statutory bodies concerned so that the same could be suitably incorporated in the admission guidelines for the information of all concerned and uploaded on the institutional website or admission portal of Department of Higher Education.

6. To enable multiple entry and exit points in the academic programs, qualifications such as certificate, diploma, and degree are organized in a series in an ascending order from level to 5 level 8. Level 5 represents certificate and level 8 represents Bachelor Degree (Honours/Research) (Table 1). The four-year UG program shall comprise courses under following subjects/categories:

(i) Major Subject (**56 credits**).
(ii) Minor Subjects (**26 credits**).
(iii) Generic Elective (**18 credits**).
(iv) Skill Enhancement Courses/Vocational Courses (**12 credits**).
(v) Ability Enhancement Courses/Foundation Courses (**24 credits**)
(vi) Field project/internship/apprenticeship/community engagement and service (**24 credits**).

Qualifications and Credit Requirements are given in Table 1. The *entry and exit* options for students, who enter the UG program, as follows:

1st Year (Level 5)

Entry 1: The entry requirement for Level 5 is successful completion of Class 12 from M.P. Board of Secondary Education, Bhopal or an equivalent examination from any other board recognized by the state Govt/University. A program of study leading to entry into the first year of the Bachelor's degree is open to those who have met the admission requirements.

Exit 1: If a student pass all the course of Level 5 and earns requisite number of credits, the student will become entitled for ***Undergraduate Certificate in the faculty of his/her Major Subject***. If he/she wants to exit, can exit the program with ***Undergraduate Certificate*** in hand.

2nd Year (Level 6)

Entry 2: The entry requirement for ***Level 6 is successful completion of Level 5***. A program of study leading to the second year of the Bachelor's degree is open to those who have met the admission requirements.

Exit 2: If a student passes all the course of Level 5 & 6 and earns requisite number of credits, the student becomes entitled for ***Undergraduate Diploma in the Faculty of his/her Major Subject***. If he/she wants to exit, can exit the program with ***Undergraduate Diploma*** in hand. A diploma requires 80 credits with 40 credits in each of the two levels.

3rd Year (Level 7)

Entry 3: The entry requirement for ***Level 7 is successful completion of Level 5 & 6***. A program of study leading to the Bachelor's degree is open to those who have met the admission requirements.

Exit 3: If the student passes all the courses of Level 5 to 7, i.e., First, Second, and Third years and earns requisite number of credits, the student becomes entitle for the ***Undergraduate Degree in the faculty of his/her Major Subject***. A Bachelor's degree requires 120 credits from Level 5 to 7, with 40 credits at level 5, 40 credits at level 6, & 40 credits at level 7.

4th Year (Level 8)

Entry 4: An individual seeking admission to a ***Bachelor's degree (Honours/Research) (Level 8)*** is a specified field of learning would have completed all requirements of the relevant ***three-year bachelor degree (Level 7)***. After completing the requirements of a three-year Bachelor's degree, candidates who meet a minimum CGPA of 7.00 shall be allowed to continue studies in the fourth year of the undergraduate program to pursue and complete the Bachelor's (Honours/Research) degree.

Exit 4: If the student passes all the course of level 5 to 8 and earns the requisite credits, the student becomes entitled for ***Undergraduate Degree (Honours/Research) in the faculty of his/her Major Subject***. A Bachelor's degree (Honours/Research) requires a total of 160 credits from level 5 to level 8, with 40 credits at level 5, 40 credits at level 6, 40 credits at level 7, & 40 credits at level 8.

Table – 1: Qualification Type & Credit Requirements		
Levels	**Qualification title**	**Credit requirements (Minimum)**
Level 5 (1^{st} year) (Entry 1)	Undergraduate Certificate in the Faculty of the Major Subject for those who exit after the first year (*Exit 1*) of the UG program (Program duration: First year of the UG program)	40
Level 6 (2^{nd} year) (Entry 2)	Undergraduate Diploma in the Faculty of the Major Subject for those who exit after two year (*Exit 2*) of the UG program (Program duration: First two years of the UG program)	80
Level 7 (3^{rd} year) (Entry 3)	Bachelor Degree in the Faculty of the Major Subject (*Exit 3*) (Program duration: Three years)	120
Level 8 (4^{th} year) (Entry 4)	Bachelor Degree in the Faculty of the Major Subject (Honours/Research) (*Exit 4*) (Program duration: Four years)	160

The credits will be awarded by the University. The credit can be calculated as follows:

- ★ One hour of theory ore one hour of tutorial or two hours of laboratory work, per week for a duration of 1 weeks resulting in the award of **one credit**;
- ★ Credits for internship shall be ***one credit per week*** on internship, subject to a ***maximum of 12 credits in a year***.

7. The minimum duration of the *undergraduate degree program* shall be of three academic years whereas that of *undergraduate degree leading to Honours/Research* shall be of four academic years.

- ❋ A student who leaves the course anytime in the middle of the program will retain the credits earned so far, which will be restored as and when he/she enters the program again at P.K. University.
- ❋ The maximum duration of Undergraduate Degree and Undergraduate Degree (Honours/Research) program for regular students shall be of 6 and 8 years, respectively.

8. Types of Courses: Each of the subject/categories (i) to (v) as specified in clause 6 shall comprise of courses. Courses are the basic units of education and/or training. Types of course be as follows:

8.1. **Core Course**: Such courses which shall be compulsorily be studied by the student as a core requirement of the program.

8.2. **Minor Course**: Such course shall be taken from relevant discipline/subject to substantially/significantly support the core courses.

8.3. **Elective Course/Generic Elective (GE)**: Generally a course, which can be chosen by the student from a pool of course, which is specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure of some other discipline/subject/domain to nurture the candidate's proficiency or skill is called an Elective Course.

NOTE: *A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice-versa.*

8.4. **Ability Enhancement Course (AEC)**: The Ability Enhancement Courses (AEC) are of two types:

- Ability Enhancement Compulsory Course (AECC) or Foundation Course.
- Skill Enhancement Course (SEC) or Vocational Course.

"**AECC**" courses are the courses based upon the content that leads to knowledge enhancement, such as

- Environmental Education
- English/Hindi communication is mandatory for all disciplines.

"**SEC**" courses are value-based/skill-based and may also be designed to focus on enhancement of skills pertaining to the Major Subject. They are aimed to provide hands-on-training, competencies, skills etc.

8.5. The syllabus for a specific program will be decided by the concerned Board of Studies of the University/Central Board of Studies (CBS) constituted by Govt. of M.P. The allowed deviation from the CBS prescribed syllabi for BOS of University will be 20% at the maximum.

9. Structure for UG program:

9.1. **First Year (Level 5)**:

A student shall be declared to have successfully completed the Level 5, if he/she acquires 12 credits in core courses of the major subject, 6 credits in core course of the minor subject, 6 credits

in generic elective, 4 credits in SEC/Vocational course, 8 credits in AEC/Foundation course, and 4 credits in Field project/internship/apprenticeship/community engagement and services.

The student can choose his/her major, minor subjects and the generic elective subject if he/she fulfills the pre-requisite prescribed by the concerned Board of Studies. A student passing Grade 12 with science can take admission in Level 5 with major and minor subjects from science/arts/commerce faculty. Major and minor subjects shall belong to the same faculty (which will be called as Main faculty), whereas generic elective subject can be chosen from any faculty. However, allotment of choices will be subject to the provisions of admission guidelines.

9.2. **Second Year (Level 6)**:

A student shall be declared to have successfully completed the Level 6, if he/she acquires 12 credits in core courses of the major subject, 6 credits in core course of the minor subject, 6 credits in generic elective, 4 credits in SEC/Vocational course, 8 credits in AEC/Foundation course, and 4 credits in Field project/internship/apprenticeship/community engagement and services.

The student shal be given the single chance at the entry level 6 to interchange the major and minor subjects, however, in such cases, it will be responsibility of the students to earn additional credits to fulfill the minimum requirement of credits prescribed for the major subjects; and only after fulfillment of such credits he/she will be entitle to earn an Undergraduate Diploma or an Undergraduate Degree.

9.3. **Third Year (Level 7)**:

A student shall be declared to have successfully completed the Level 6, if he/she acquires 12 credits in core courses of the major subject, 6 credits in core course of the minor subject, 6 credits in generic elective, 4 credits in SEC/Vocational course, 8 credits in AEC/Foundation course, and 4 credits in Field project/internship/apprenticeship/community engagement and services, preferably related to major and/or minor subjects.

9.4. **Fourth Year (Level 8)**:

(A) Bachelor with Honours: A student shall be declared to have successfully completed the Level 8 for Bachelor with Honours, if he/she acquires 20 credits in core courses of the major subject, 4 credits course in Research methodology, 4 credits in dissertation, and 12 credits in internship/apprenticeship related to major subjects.

(B) Bachelor with Research: A student shall be declared to have successfully completed the Level 8 for Bachelor with Research degree, if he/she acquires 20 credits in core courses of the major subject, 4 credits course in Research methodology, 4 credits in minor subject, and 12 credits for Research Project and disciplinary/interdisciplinary Undergraduate thesis related to major subjects.

The proposed structure for Undergraduate program in annual system is shown in Table 2.

Table 2: Proposed structure for Undergraduate Program: Annual system									
Level	**Year**	**Main Faculty**		**Any Faculty**	**Ability Enhancement Courses (AEC)**		**Field project/internship/ apprenticeship/ community engagement & service**	**Credits in a Year**	**Qualification (Credit requirement) *in Main Faculty***
		Subject I	***Subject II***	***Subject III***	***AECC***	***SEC***			
		Major	*Minor*	*Generic Elective*	*Foundation Course*	*Vocational Course*	*Main/Inter/Intra faculty*		
		No. of courses (Credits)	**No. of courses (Credits)**	**No. of courses (Credits)**	**No. of courses (Credits)**	**No. of courses (Credits)**	**No. of courses (Credits)**		
Level 5	1	1 (6 credits) 1 (6 credits)	1 (6 credits)	1 (6 credits)	4 (4 x 2 = 8 credits)	1 (4 credits)	1 (4 credits)	12 + 6 + 6 + 8 + 4 + 4 = 40	(40) Undergraduate Certificate
Level 6	2	1 (6 credits) 1 (6 credits)	1 (6 credits)	1 (6)	4 (4 x 2 = 8 credits)	1 (4 credits)	1 (4 credits)	12 + 6 + 6 + 8 + 4 + 4 = 40	(80) Undergraduate Diploma
Level 7	3	1 (6 credits) 1 (6 credits)	1 (6)	1 (6)	4 (4 x 2 = 8 credits)	1 (4 credits)	1 (4 credits)	12 + 6 + 6 + 8 + 4 + 4 = 40	(120) Bachelor Degree
Level 8	4	2 (6 credits each) (2 x 6 = 12 credits)	1 Research Methodology (4 credits)				1 (4 credits) Dissertation (Only for Honours)	20 + 4 + 16 = 40 credits (Honours)	(160) Bachelor Degree (Honours)
		2 (4 credits each) (2 x 4 = 8 credits)	1 (4 credits) (Only for Research)				1 (12 credits) Internship/Apprenticeship or Research Project (Both for Honours & Research)	20 + 8 + 12 = 40 credits (Research)	(160) Bachelor Degree (Research)

10. Examination & Evaluation:

10.1. Generally, each course will correspond to an examination paper comprising of external and internal valuation. The year-end theory examinations for Major subject, Minor subject and Generic Elective will be of 3 hours while Vocational (SEC) and Foundation Course (AECC) will be of 2 hours duration.

10.2. **Description and distribution of internal and external marks, and the minimum passing marks for both theory & practical papers and project are given in the end of respective papers in the syllabi section. However, the following points should be noted.**

- *Distribution of marks for theory papers:*
  - *A theory paper of 4 credits (100 marks)* will have two exam components as described below except the field project/internship/apprenticeship/community engagement and service:
    - **Internal evaluation/Continuous Comprehensive Evaluation (CCE): 30 marks** [Class Test – 20 marks; Assignment/Presentation – 10 marks] and
    - **External/University Exam (UE): 70 marks** [Time: 3 hours; Question pattern: As per Bloom's taxonomy.]

  The question paper of the external examination should preferably contain multiple choice questions, objective questions, memory based questions, conceptual understanding/explanation, brief & long answers, skill based questions, problems, etc., (i.e., Bloom's taxonomy). Where the internal assessment is for 30 marks, the continuous evaluation of the student will be conducted at fur times (one in each quarter of the academic session) by conducting four tests of 10 marks each. Of these, three must be written tests and the fourth one must be assignment/presentation for theoretical course. Marks obtained in best two written tests out of three and in the fourth test (assignment/presentation) will be awarded to the student. Each student shall have to appear in at least three tests and year-end examination; failing which, the student will be awarded Ab grade in that course.

  - *A theory paper of 2 credits (50 marks)* will only have UE of duration of 2 hours..
- *Distribution of marks for practical/laboratory papers (100 marks):* It will have two exam components as described below
  - **Internal Assessment: 30 marks – One exam [**Class Interaction/Quiz: 15 marks; Attendance: 5 marks, Assignments (Charts/Model seminar/Rural service/Technology dissemination/Report of excursion/Lab. visit/Survey/Industrial visit): 10 marks]
  - **B. External Assessment: 70 marks. [**Viva voce on Practical: 10 marks; Practical Record File: 10 marks, Table work/Experiment: 50 marks.]

- ❖ *Distribution of marks for laboratory/field/project work /field project/internship/apprenticeship/community engagement and service (100 marks):* In case of laboratory/field/project work /field project/internship/apprenticeship/community engagement and service based courses, the marks will be distributed as follows:
  - ★ Collection of data/survey/research etc. & analysis: 50%
  - ★ One progress report: 20%
  - ★ Submission of final report/dissertation & final viva-voce: 30%

10.3. Total marks obtained in year-end examination and continuous evaluation will be considered for awarding the grade in the course as explained in 10.4.

10.4. The grading will be made on 10-point scale as described below in Table 3:

Table 3: Grading system on 10 point scale

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

10.5. If a student obtains F or Ab grade in any course(s), he/she will be treated to have supplementary/failed in the course(s). He/she has to reappear in the examinations of that course(s) as and when conducted by the University. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat year-end examination to decide the grade in the repeat course(s).

10.6. The student will be promoted to the next year if he/she secures at least half of the total credits (viz: 20 credits out of 40 credits in annual system) in a year. In case the secures less than half of the total credits in any year, then the student will be declared fail in that year as he/she will be asked to repeat the entire year and that year will be treated as zero year. In such cases the student will not be promoted to the next year.

10.7. If a student passes in all the courses offered in any year then will be declared pass in that year. If s student secures at least half of the total credits in a year and fails in some courses offered in that year then he/she will be provisionally promoted to the next year with supplementary in those courses in which he/she fails.

10.8. If the student fails to pass all the courses in the next supplementary examination, the provisional promotion will be terminated, but he/she will be given a second chance to pass the failed course. If the student does not successfully complete the concerned year even after the aforesaid second chance, he/she shall be treated as fail in that year and will be asked to repeat the entire year and that year will be treated as zero year.

10.9. Repetition of theory/practical course is allowed only to those candidates who get F or Ab grade in the course or has failed in the year. The student has to pay the prescribed fee for repeating the course.

10.10. On account of valid reasons, a student may withdraw from a year. In such case that year will be treated as zero year.

10.11. In case of zero year, the student will not be promoted to the next year till he/she clears that year. The University may allow such a student to re-register in that year in the coming years. The student has to pay annual fee again in such case and may not be eligible for scholarship. If the student withdraws within one from starting of the academic year then annual fee will not be charged again.

10.12. The provision for revaluation of answer book in annual system will be available as per the existing rules of the University.

11. Calculation of AGPA/CGPA:

11.1. Annual Grade Point Average (AGPA) is a measure of performance of the student in a year. It is ratio of total credit points secured by a student in various courses registered in that year and the total course credits taken during that year, i.e.,

$$AGPA\ (Y_i) = \frac{\sum C_i\, XG_i}{\sum C_i}$$

where Y_i is the i-th year, C_i is the number of credits of the i-th course in the year (Y_i) and G_i is the grade point scored by the student in the i-th course.

11.1. The Annual Grade Point Average (AGPA) and Cumulative Grade Point Average (CGPA) will be calculated as weighted average of credit points secured by the student, except the credits of additional course, if any. The AGPA and CGPA shall be rounded up to 2 decimal places and reported in the grade sheet.

The calculation of AGPA in annual system will be done as per follows (Table 4).

Table 4: Calculation of AGPA:

Course	Credits (C)	Grade	Grade Point (GP)	Credit Points (C X GP)	AGPA (Total Credit Point/Total Credit)
Course 1	6	A	8	48	276/40 = 6.90
Course 2	6	C	5	30	
Course 3	6	B+	7	42	
Course 4	6	O	10	60	
Course 5	4	B	6	24	
Course 6	4	P	4	16	
Course 7	4	A+	9	36	
Course 8	4	C	5	20	
TOTAL	40	-	-	276	

11.2. CGPA is a measure of overall cumulative performance of a student over all the years completed. The CGPA is the ratio of total credit points secured by a student in various courses in all the years completed and the sum of the credits of all course in all the years completed. In case of annual system CGPA will be calculated as per follows:

$$CGPA\ (Y_i) = \frac{\sum[C_i\ XAGPA\ (Y_i)]}{\sum C_i}$$

where AGPA (Y_i) is the AGPA of the *i*-th year and C_i is the total number of credits in the *i*-th year.

Table 5 shows an example.

Table 5: Calculation of CGPA:				
Year	**Credits**	**AGPA**	**Credits x AGPA**	**CGPA**
1	40	7.50	300.00	CGPA = Total (Credits x AGPA)/Total Credits
2	40	7.58	303.20	
3	40	7.32	292.80	CGPA = 1229.60/160
4	40	8.34	333.60	= 7.685
Total	160		1229.60	= 7.69 (rounded off to second decimal point)

12. On completing all requirements for award of the undergraduate certificate/diploma/degree, the CGPA will be calculated and this value will be indicated on the certificate/diploma/degree. The 3-year and 4-year undergraduate degree should also indicate the Division obtained as per follows (Table 6):

Table 6: Criterion for division	
Division	**Criterion**
First division with distinction	The candidate has earned minimum number of credits required for the award of the degree with CGPA of 8.00 or above.
First division	The candidate has earned minimum number of credits required for the award of the degree with CGPA of 6.50 or above but less than 8.00.
Second division	The candidate has earned minimum number of credits required for the award of the degree with CGPA of 5.00 or above but less than 6.00.
Pass	The candidate has earned minimum number of credits required for the award of the degree with CGPA of 4.00 or above but less than 5.00.

The conversion of CGPA into percentage will be as follow to facilitate its application in other academic matters:

Equivalent Percentage = CGPA x 10.

The percentage will be rounded off up to second decimal point.

13. The candidate shall be awarded a certificate/diploma/degree when he/she successfully earns the minimum requisite credits for the certificate/diploma/degree.

14. A Grade Card shall be issued to all the students after every academic year based on the grades earned. The course details (code, title, number of credits, grade secured) along with AGPA of every year and CGPA earned till that Academic Year will be displayed in the grade card.

15. Requirement of attendance will be as per University Ordinance governing the examinations. In general attendance of at least seventy-five percent of theory lectures and practical separately will be required in each course to sit in the year end examination.
For special reasons such as prolonged illness deficiency in percentage of attendance not exceeding fifteen percent of the total number of lectures delivered and practical/sessional held in each course may be condoned by the Vice-Chancellor of the University.

16. If any question arises relating to the interpretation of the provisions of the Ordinance, it shall be referred to the state government whose decision thereon shall be applicable.

17. The guidelines, related to this program, issued by the statutory body, i.e., UGC issued from time to time will be adopted for implementation.

18. If UGC notifies any change in future in its Regulations in this regard, then the same will be incorporated in the existing Ordinance with the approval of Vice-Chancellor on the recommendation of the Higher Education Department.

19. **Intake**: 60 each in Physics, Chemistry, Mathematics (PCM) stream and Botany, Zoology, Chemistry, (BZC) stream.

20. **Medium of Instruction**: English

21. Paper/Course Code: Each paper/course offered by the **Faculty of Science** (*Use the name of your Faculty/School*) is identified by a unique course code comprising of **eight letters/numbers** indicating

i. Program/level of program - *first one letter in uppercase*, i.e., **C** for **Certificate**, **D** for **Diploma**, **U** for **Undergraduate**, **M** for **Postgraduate**, & **D** for **Doctoral (Ph.D.)** Program,
ii. Discipline/Subject - next four letters in uppercase, i.e., **PHYS** for **PHYS**ics, **HIND** for **HIND**i etc.),
iii. Year - Next digit starting from 1, and

iv. Course/Paper Number - next two digits starting from 01 for each year.

NOTE:

A. There should not be any space/special character (hyphen, colon, semi-colon etc.,) among the characters/letters.
B. Insert Colon after the Code, insert space after the Colon, and write the name of the paper.

Example: UPHYS101: Thermodynamics & Statistical Physics stands for first paper in Physics in the first year of undergraduate program and the name of the paper is Thermodynamics & Statistical Physics

Abbreviation used for Courses/Papers for various subjects:

(i) PHYS: Physics
(ii) CHEM: Chemistry
(iii) MATH: Mathematics.
(iv) BIOT: Biotechnology.
(v) BIOC: Biochemistry.
(vi) ZOOL: Zoology.
(vii) BOTA: Botany.
(viii) ENGL: English.
(ix) ENVS: Environmental Studies/Environmental Education/Environmental Science.
(x) YOGM: Yoga & Meditation.
(xi) HIND: Hindi.
(xii) COMP: Computer science/Computer fundamental.
(xiii) BIOI: Bioinformatics.
(xiv) MICB: Microbiology

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B.Sc. 1st Year (Entry 1: Level 5 & Exit 1)

Undergraduate Certificate in Major Subject

Course Structure & Syllabi

Total credits: 40 credits

Course Structure:

Ability Enhancement Courses (AEC), Field project/internship/apprenticeship/community engagement service courses are compulsory for all 1st year UG students in Faculty of Science.

Ability Enhancement Compulsory Course (AEC) – 2 types

Type– 1: Ability Enhancement Compulsory Course (AECC) or Foundation Course
Type – 2: Skill Enhancement Course (SEC) or Vocational Course

Type– 1: Ability Enhancement Compulsory Course (AECC) or Foundation Course

Number of subjects/courses/papers: 04 – All are compulsory.

1. English – 2 credits (*50 marks*).
2. Environmental Education – 2 credits (*50 marks*).
3. Yoga & Meditation – 2 credits (*50 marks*).
4. Hindi – 2 credits (*50 marks*).

Type – 2: Skill Enhancement Course (SEC) or Vocational Course

Number of paper: 01 – Compulsory

1. Computer Fundamentals – 4 credits (2 credits theory: *50 marks* & 2 credits practical: *100 marks*).

Field project/internship/apprenticeship/community engagement service: 04 credits (*100 marks*) - Compulsory. Topics will be decided by the Faculty of Science. Marks will be distributed as follows:

- ★ Collection of data/survey/research etc. & analysis: 50%
- ★ One progress reports: 20%
- ★ Submission of final report/dissertation & final viva-voce: 30%

Credits from AEC & Field project/internship/apprenticeship/community engagement:

8 + 4 + 4 = 16 credits

***Credits from major, minor, & general elective*: 12 + 6 + 6 = 24 credits (see the table below).**

Total credits: 16 + 24 = 40 credits.

B.Sc. 1st Year Course Structure (Level 5) – Faculty of Sciences								
Compulsory courses for all B.Sc. 1st year students (*PCM & BZC streams*) (Level 5)								
Sl. No.	***Course Code (T: Theory; P: Practical)***	***Course Title***	***Credits (L: Lecture; T: Tutorial; P: Practical)***			***Marks Distribution***		***Total Marks (CCE +UE)***	***Subject/ Course type/ Total Credits***
			L	**T**	**P**	**CCE**	**UE**		
1.	UENGL101	English Language & Indian Culture	2	0	0	0	50	50	English/ AECC1/2
2.	UENVS101	Environmental Education	2	0	0	0	50	50	Environment / AECC2/2
3.	UYOGM101	Yoga & Meditation	2	0	0	0	50	50	Yoga/AECC3/2
4.	UHIND101	Bhasha aur Sanskriti	2	0	0	0	50	50	Hindi/AECC4/2
5.	UCOMP101	Computer Fundamentals	2	0	0	0	50	50	Computer/ SEC/4
6.	UCOMP102	Computer Fundamentals Lab.	0	0	2	30	70	100	
7.	(UXXXX1YY) (Major paper)	Undergraduate 1st year Project in Major (Physics/Chemistry etc.)	4			100		100	Project/ Internship etc./4
Total								**450**	**16**
Subject combination for Physics Major (B.Sc. 1st year: Level 5) (*PCM stream/branch*) (Each paper carries 100 marks)									
Sl. No.	***Course Code (T: Theory; P: Practical)***	***Course Title***	***Credits (L: Lecture; T: Tutorial; P: Practical)***			***Marks Distribution***		***Total Marks (CCE +UE)***	***Subject/ Course type/ Total Credits***
			L	**T**	**P**	**CCE**	**UE**		
1.	UPHYS101	Mechanics & General Properties of Matter	4	0	0	30	70	100	Physics/ Major/ 12
2.	UPHYS102	Mechanics & General Properties of Matter Lab.	0	0	2	30	70	100	
3.	UPHYS103	Thermodynamics & Statistical Physics	4	0	0	30	70	100	
4.	UPHYS104	Thermodynamics & Statistical Physics Lab.	0	0	2	30	70	100	
5.	UMATH101	Calculus and Differential Equations	5	1	0	30	70	100	Maths/Minor/6
6.	UCHEM101	Fundamentals of Chemistry	4	0	0	30	70	100	Chemistry/ GE/6
7.	UCHEM102	Qualitative & Quantitative Chemical Analysis Lab.	0	0	2	30	70	100	
Total								**700**	**24**
Subject combination for Chemistry Major (B.Sc. 1st year: Level 5) (*PCM stream/branch*) (Each paper carries 100 marks)									

1.	UCHEM101	Fundamentals of Chemistry	4	0	0	30	70	100	Chemistry/ Major/ 12
2.	UCHEM102	Qualitative & Quantitative Chemical Analysis	0	0	2	30	70	100	
3.	UCHEM103	Analytical Chemistry	4	0	0	30	70	100	
4.	UCHEM104	Analytical Process & Techniques Lab.	0	0	2	30	70	100	
5.	UPHYS101	Mechanics & General Properties of Matter	4	0	0	30	70	100	Physics/ Minor/6
6.	UPHYS102	Mechanics & General Properties of Matter Lab.	0	0	2	30	70	100	
7.	UMATH101	Calculus and Differential Equations	5	1	0	30	70	100	Maths/ GE/6
Total								**700**	**24**
Subject combination for Mathematics Major (B.Sc. 1st year: Level 5) (*PCM stream/branch*) (Each paper carries 100 marks)									
1.	UMATH101	Algebra, Vector Analysis and Geometry	5	1	0	30	70	100	Mathematics/ Major/ 12
2.	UMATH102	Calculus and Differential Equations	5	1	0	30	70	100	
3.	UPHYS101	Mechanics & General Properties of Matter	4	0	0	30	70	100	Physics/ Minor/6
4.	UPHYS102	Mechanics & General Properties of Matter Lab.	0	0	2	30	70	100	
5.	UCHEM101	Fundamentals of Chemistry	4	0	0	30	70	100	Chemistry/ GE/6
6.	UCHEM102	Qualitative & Quantitative Chemical Analysis Lab.	0	0	2	30	70	100	
Total								**600**	**24**
Subject combination for Zoology Major (B.Sc. 1st year: Level 5) (*BZC stream/branch*) (Each paper carries 100 marks)									
1.	UZOOL101	Animal Diversity: Non-Chordata	4	0	0	30	70	100	Zoology/ Major/ 12
2.	UZOOL102	Invertebrate Lab.	0	0	2	30	70	100	
3.	UZOOL103	Cell Biology, Reproductive Biology and Development Biology	4	0	0	30	70	100	
4.	UZOOL104	Cytology, Reproductive Biology and Embryology Lab.	0	0	2	30	70	100	
5.	UCHEM101	Fundamentals of Chemistry	4	0	0	30	70	100	Chemistry/ Minor/6
6.	UCHEM102	Qualitative & Quantitative Chemical Analysis Lab.	0	0	2	30	70	100	
7.	UBOTA101	Applied Botany	4	0	0	30	70	100	Botany/ GE/6
8.	UBOTA102	Applied Botany Lab.	0	0	2	30	70	100	
Total								**800**	**24**
Subject combination for Botany Major (B.Sc. 1st year: Level 5) (*BZC stream/branch*) (Each paper carries 100 marks)									
1.	UBOTA101	Applied Botany	4	0	0	30	70	100	Botany/ Major/ 12
2.	UBOTA102	Applied Botany Lab.	0	0	2	30	70	100	
3.	UBOTA103	Basic Botany	4	0	0	30	70	100	

4.	UBOTA104	Basic Botany Lab.	0	0	2	30	70	100	
5.	UCHEM101	Fundamentals of Chemistry	4	0	0	30	70	100	Chemistry/ Minor/6
6.	UCHEM102	Qualitative & Quantitative Chemical Analysis Lab.	0	0	2	30	70	100	
7.	UZOOL101	Animal Diversity: Non-Chordata	4	0	0	30	70	100	Zoology/ GE/6
8.	UZOOL102	Invertebrate Lab.	0	0	2	30	70	100	
		Total						**800**	**24**
Subject combination for Chemistry Major (B.Sc. 1st year: Level 5) (*BZC stream/branch*) (Each paper carries 100 marks)									
1.	UCHEM101	Fundamentals of Chemistry	4	0	0	30	70	100	Chemistry/ Major/ 12
2.	UCHEM102	Qualitative & Quantitative Chemical Analysis	0	0	2	30	70	100	
3.	UCHEM103	Analytical Chemistry	4	0	0	30	70	100	
4.	UCHEM104	Analytical Process & Techniques Lab.	0	0	2	30	70	100	
5.	UBOTA101	Applied Botany	4	0	0	30	70	100	Botany/ Minor/6
6.	UBOTA102	Applied Botany Lab.	0	0	2	30	70	100	
7.	UZOOL101	Animal Diversity: Non-Chordata	4	0	0	30	70	100	Zoology/ GE/6
8.	UZOOL102	Invertebrate Lab.	0	0	2	30	70	100	
		Total	**800**					**24**	
Subject combination for Biotechnology Major (B.Sc. 1st year: Level 5) (*BZC stream/branch*) (Each paper carries 100 marks)									
1.	UBIOT101	Cell Biology and Biotechnology	4	0	0	30	70	100	Biotechnology/ Major/ 12
2.	UBIOT102	Cell Biology and Biotechnology Lab.	0	0	2	30	70	100	
3.	UMICB101	Microbiology and Immunology	4	0	0	30	70	100	
4.	UMICB102	Microbiology and Immunology Lab.	0	0	2	30	70	100	
5.	UBIOI101	General Introduction to Bioinformatics	4	0	0	30	70	100	Bioinformatics/ Minor/6
6.	UBIOI102	General Introduction to Bioinformatics Lab.	0	0	2	30	70	100	
7.	UCHEM101	Fundamentals of Chemistry	4	0	0	30	70	100	Chemistry/ GE/6
8.	UCHEM102	Qualitative & Quantitative Chemical Analysis Lab.	0	0	2	30	70	100	
Total								**800**	**24**

B.Sc. 1st year (Annual system)

Syllabi

Ability Enhancement Course (AEC)

Type– 1: Ability Enhancement Compulsory Course (AECC) or Foundation Course

Subject: English (Foundation Course)

Part A - Introduction

Course Code: UENGL101
Course Title: English Language & Indian Culture
Course Type: Foundation Course.
Credit Value: 2 credits.
Total Marks: 50; Min. Passing Marks: 18
Pre-requisite (if any): To study this course, a student should have basic knowledge of English language. This course will be suited for all the students of UG level under the Foundation Course Category.
Course Learning Outcomes (CLO): Through this course, the students will be able to:

1. Prepare for various competitive exams by developing their English language competence.
2. Promote their comprehension skills by being exposed to a variety of texts and their interpretations.
3. Build and enhance their vocabulary.
4. Develop their communication skills by strengthening grammar and usage.
5. Inculcate values, which make them aware of national heritage and environmental issues, making them responsible citizens.

Part B - Content of the Course

Unit I: Reading, Writing and Interpretation Skills (No. of lectures: 10)**:**

1. Where The Mind is Without Fear – Rabindranath Tagore [Key word: Patriotism].
2. National Education – M.K. Gandhi (Key word: Edification].
3. The Axe – R.K. Narayan [Key word: Environment].
4. The Wonder that Was India – A.L. Basham (an excerpt) [Key word: Indianess].
5. Preface to the Mahabharata – C. Rajagopalchari [Key word: Indian mythology].

Unit II: Comprehensive Skill (No. of lectures: 10)**:** Unseen passage followed by multiple choice questions

Unit III: Basic Language Skills (No. of lectures: 10)**:**

1. Vocabulary building: Suffix, prefix, synonyms, antonyms, homophones, homonyms, & one-word substitution.
2. Basic grammar: Noun, pronoun, adjective, verb, adverb, prepositions, articles, time, & tense.

Part C - Learning Resources

Text books:

1. Essential English Grammar – Raymond Murphy, Cambridge University Press.
2. Practical English Grammar Exercises 1 – A.J. Thomson & A.V. Martinet, Oxford India.
3. Practical English Usage – Michael Swan, Oxford.
4. English Grammar in Use – Raymond Murphy, Cambridge University Press.

Part D - Assessment & Evaluation: External Exam/University Exam (UE): 50 marks [Time: 2 hours; Pattern/type: Objective/true-false/descriptive type questions to be asked.]

Subject: Environmental Education (Foundation Course)

Part A - Introduction

Course Code: UENVS101
Course Title: Environmental Education
Credit Value: 2 credits.
Total Marks: 50; Min. Passing Marks: 18
Pre-requisite (if any): A course intended to create awareness about the life of human being which is an integral part of environment; and to inculcate the skills required to protect the environment from all sides. To study this course, the student must have a knowledge about the environmental components, pollution, biodiversity, and ecosystem at class 12^{th} level.
Course Learning Outcomes (CLO): Through this course, the students will be able to:

1. Understand various aspects of life forms, ecological processes, and the impacts on them by the human during Anthropocene era.
2. Build capabilities to identify relevant environmental issues, analyze the various underlying causes, evaluate the practices and policies, and develop framework to make inform decisions.
3. Develop empathy for all life forms, awareness and responsibility towards environmental protection and nature preservation.
4. Develop the critical thinking for shaping strategies such as scientific, social, economic, administrative & legal, environmental protection, conservation of biodiversity, environmental equity and sustainable development. Inculcate values, which make them aware of national heritage and environmental issues, making them responsible citizens.
5. Prepare for competitive exams.

Part B - Content of the Course

Unit I: Environment and Natural Resources (No. of lectures: 10):

1. Multidisciplinary nature, score, and importance of environment.
2. Components of environment: Atmosphere, hydrosphere, lithosphere, & biosphere.

3. Brief account of natural resources & associated problems: Land resource, water resource, energy resource.
4. Concept of sustainability and sustainable development.

Keywords: Environment, Forest, Mineral, Food, Land, Water, Energy, Sustainable development.

Unit II: Biome, Ecosystem, and Biodiversity (No. of lectures: 10):
1. Major biomes: Tropical, temperate, forest, grassland, desert, tundra, wetland, estuarine, & marine.
2. Ecosystem: Structure function & types, their preservation & restoration.
3. Biodiversity and its conservation practices.

Keywords: Biome, Ecosystem, Biodiversity.

Unit II: Environmental Pollution, Management, and Social Issues (No. of lectures: 10):
1. Pollution: Types, control measures, management, and associated problems.
2. Environmental law & legislation: Protection & conservation acts.
3. International agreement & program.
4. Environmental movements, communications, and public awareness program.
5. National & international organizations related to environment conservation and monitoring.
6. Role of information technology in environmental and human health.

Keywords: Pollution, Environmental legislation, Environmental movement, Environmental program, & organization.

Suggested activities (at least one):
1. Visit to an area to document environmental assets: Rivers/forest/flora/fauna.
2. Visit to a local polluted site: Urban/rural/industrial/agricultural.
3. Study of simple ecosystem.

Part C - Learning Resources

Text books:

1. J.S. Singh, S.P. Singh, & S.R. Gupta, Ecology, Environment Science, & Conservation, S. Chand, New Delhi, 2018.
2. S. Divan & A. Rosencranz, Environmental Law & Policy in India: Cases, Material, & Status, Oxford University Press.
3. E.P. Odum, Fundamentals of Ecology, Philadelphia Saundres, 1971.
4. E. Bharucha, Environmental studies, University Press India Pvt. Ltd., Hyderabad, 2014.
5. A. Kaushik & C.P. Kaushik, Perspectives in Environmental Studies, New Age International Pub., 2018.
6. D.K. Asthana & M. Asthana, A Textbook of Environmental Studies, S. Chand Publ., New Delhi, 2007.

Part-D: Assessment & Evaluation: External Exam/University Exam (UE): 50 marks [Time: 2 hours; Pattern/type: Objective/true-false/descriptive type questions to be asked.]

Subject: Yoga and Meditation (Foundation Course)

Part A - Introduction

Course Code: UYOGM101
Course Title: Yoga & Meditation
Course Type: Foundation Course.
Credit Value: 2 credits.
Total Marks: 50; Min. Passing Marks: 18
Pre-requisite (if any): None.
Course Learning Outcomes (CLO): After studying this course, the students will be able to take care of their own physical, mental, emotional, social, & spiritual health.

Part B - Content of the Course

Unit I: Introduction to Yoga and Yogic Practices (No. of lectures: 10):
1. Yoga: Etymology, definitions, aim, objectives, & misconceptions.
2. Yoga: Its origin, history, & development.
3. Rules and regulations to be followed by Yoga Practitioners.
4. Introduction to yoga practices.
5. Shatkarma: Meaning, purpose, and their significance in Yoga Sadhana.
6. Introduction to yogic loosening practices & Surya Namaskar.

Keywords: History & Development of Yoga, Shatkarma, Common Yogic Practices.

Unit II: Breathing Practices and Pranayama (No. of lectures: 10):
1. Sectional Breathing (Abdominal, thoracic, & clavicular)
2. Yogic deep breathing.
3. Concept of Puraka, Rechaka, & Kumbhaka.
4. Concept of Bandha & Mudra.
5. Anulmoa Viloma/ Nadi Shodhana.
6. Shitali & Bhramari.

Keywords: Sectional breathing, Deep breathing, Bandha & Mudra, Shitali & Bhramari.

Unit III: Practices leading to Meditation (No. of lectures: 10):
1. Recitation of Pranava Mantra.
2. Recitation of Hymns, in vocations & prayers.
3. Anter Maun.
4. Breath Meditation.
5. Om Dhyana.

Keywords: Pranava mantra, Antermaun, Breath meditation, Om dhyana.
Part C - Learning Resources

Text books:

1. S.P. Singh & Yogi Mukesh.Foundation of Yoga, Standard Publication, New Delhi, 2010.
2. Swami DhirendraBrahmchari, YogasanaVijnana, Dhirendra Yoga Publication, New Delhi, 1966.
3. H.R. Nagendra, Asana, Pranayama, Mudra, Bandh (APMB), Yoga Publication Trust, Munger, 2013.
4. H.R. Nagendra, Asana, Pranayama, Mudra, Bandh, Swami VivekanandaYogPrakashan, Bangalore, 2002.
5. IshwarBhardwaj, SaralYogasana, Satyam Publishing House, New Delhi, 2018.
6. ShriRai Singh Chouhan, Mudra Rahasya, Bhartiya Yog Sansthan, New Delhi, 2014.
7. Dr. V.P. Sanha, Dhyan Yoga, Bhartiya Yog Sansthan, New Delhi, 1987.

Part-D: Assessment & Evaluation: External Exam/University Exam (UE): 50 marks [Time: 2 hours; Pattern/type: Objective/true-false/descriptive type questions to be asked.]

Part – 2: Skill Enhancement Course (SEC) or Vocational Course

Number of paper: 01 – Compulsory.

1. Computer Application

Total Credits: 04 credits.

Subject: Computer Application (SEC/Vocational Course)

Part A - Introduction

Course Code: UCOMP101

Course Title: Computer Fundamentals

Pre-requisite (if any): None.

NOTE: Instructor should take this course in the computer lab. so that demonstration and hands on training can be given to the students along with the lectures. There is no separate lab. session for this course. Lab./hands on training sessions are major component of this course.

Course Learning Outcomes (CLO): On the completion of this course, the students will be able to:

1. Understand the fundamentals of computer.
2. Use computer in his/her daily life as well as can do assigned official work with ease.
3. Troubleshoot issues related to working with computer & internet.
4. Communicate through internet as well as can use IT for day to day work

Credit Value: 2 credits.

Total Marks: 50 = 50; Min. Passing Marks: 18

Part B - Content of the Course

Unit I: Knowing computer (No. of lectures including hands on training: 10): What is computer, basic applications of computer, components of computer system, modern Central Processing Unit (CPU), video display unit, keyboard & mouse, optical storage devices, basics of hard drive, concepts of hardware & software, concept of computing, data & information, checking power supply, system software, application software, types of operating system, role of operating system, utility programs, packages, communication software, commonly used application software.

Unit II: MS Windows Operating System (No. of lectures including hands on training: 10): Definition & functions, basic components of Windows, icons, desktops, taskbar, notification area, files & folders, start menu operations, my computer, network neighborhood, recycle-bin, windows explorer, status bar, creating & renaming of files & folders.

Unit III: (No. of lectures including hands on training: 10):

1. **MS Word:** Introduction, Windows 2007, customizing the Word application, document views, creating & editing document, selecting, deleting, replacing text, copying text to another file, insert, formatting text & paragraph, using the Font, dialog box, paragraph formatting using bullets & numbering in paragraphs, checking spelling, line spacing, margins, space before & after paragraph, navigating through a Word document, a quick look at macros, printing document, print preview.
2. **Excel 2007:** Introduction, workbook, worksheet, formatting in excel.
3. **MS Power Point:** Introduction, creating a presentation.

Unit IV: Internet (No. of lectures including hands on training: 10): Introduction, WWW & web browsers, basics of computer networks, LAN, WAN, application of internet, connectivity related troubleshooting, web browsing software, understanding URL, domain name, IP address, using e-governance website, basics of electronic mail, getting an email account, sending & receiving emails, accessing sent emails, instant messaging, netiquettes (Internet etiquette).

Unit IV: (No. of lectures including hands on training: 10): Useful Google tools such as drive, sheet, doc, meet etc., basics of Electronic Data Interchange (EDI), firewall, computer virus & anti-virus software, internet security & privacy, social network, types of payment system, electronic cheque, smart card, digital signature & digital certificate.

Unit V: (No. of lectures including hands on training: 20): Any useful free software of teaching-learning, website for learning resources, free basic computational website, drawing software and other necessary skills as decided by the course instructor.

Part C - Learning Resources

Text books:

1. C. Xavier, Introduction to Computers, New Age International.
2. P. Sinha & P.K. Sinha, Computer Fundamentals: Concepts, Systems & Applications, BPB Publications.
3. A. Leon & M. Leon, Fundamentals of Information Technology, Vikas Publishing House, New Delhi.
4. W. Wang, Microsoft Office 2019 for Dummies, Wiley.

Part D - Assessment & Evaluation: External Exam/University Exam (UE): 50 marks [Time: 2 hours; Pattern/type: Objective/true-false/descriptive type questions to be asked]

Subject: Computer Application (SEC/Vocational Course)

Part A - Introduction

Course Code: UCOMP102
Course Title: Computer Fundamentals Lab.
Pre-requisite (if any): None.
Course Learning Outcomes (CLO): On the completion of this course, the students will be able to:

5. Understand the fundamentals of computer.
6. Use computer in his/her daily life as well as can do assigned official work with ease.
7. Troubleshoot issues related to working with computer & internet.
8. Communicate through internet as well as can use IT for day to day work

Credit Value: 2 credits.
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35

Part B - Content of the Course

Related to theory.

Part C - Learning Resources

Text books:

5. C. Xavier, Introduction to Computers, New Age International.
6. P. Sinha & P.K. Sinha, Computer Fundamentals: Concepts, Systems & Applications, BPB Publications.
7. A. Leon & M. Leon, Fundamentals of Information Technology, Vikas Publishing House, New Delhi.
8. W. Wang, Microsoft Office 2019 for Dummies, Wiley.

Part D – Assessment and Evaluation

A. Internal Assessment: Continuous Comprehensive Evaluation (CCE): 30 marks [Class Interaction/Quiz – 15 marks; Attendance – 05 marks; Assignments (Charts/Model/Seminar/Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey/ Industrial visit) – 10 marks.]

B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Viva-voce on Practical – 10 marks; Practical Record File – 10 marks; Table work/Experiments – 50 marks.]

Subject: Physics

Course Title: Mechanics and General Properties of Matter

Part A - Introduction

Course Code: UPHYS101
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Physics in 12^{th} class
Course Learning Outcomes (CLO):

1. The course would empower the students to develop the idea about the behavior of physical bodies.
2. It will provide the basic concepts related to the motion of all the objects around us in daily life.
3. The students would be able to build foundation to various applied field in science and technology especially in the field of mechanical engineering.
4. The studies will acquire the knowledge of basic mathematical methods to solve the various problems in physics.
5. The students will be able to understand the relativistic effect and the relation between energy and mass.

Unit I: Historical background and Mathematical Physics (No. of Lectures: 12):

1. Historical background:
   1.1. A brief historical background of mathematics and mechanics in the context of India and Indian culture.
   1.2. A brief biography of Varahmihira and Vikram Sarabhai with their major contribution to science and society.
2. Mathematical Physics:
   2.1. Scalar and vector fields, gradient of a scalar field and its physical significance.
   2.2. Vector integral: Line integral, surface integral, & volume integral, divergence of a vector field & its significance, Gauss divergence theorem.
   2.3. Curl of a vector field and its physical significance, Stokes and Gauss theorem, numerical problems based on the above topics.

Keywords/Tags: Scalar field, Vector field, Vector integral, Gradient, Divergence, Curl.

Unit II: Mechanics of Rigid and Deformable Bodies (No. of Lectures: 12):

1. Rigid body mechanics: System of particles and concept of rigid body, torque, center of mass (position of the center of mass, motion of the center of mass), conservation of linear & angular momentum with examples, single stage and multistage rocket.
2. Mechanic of deformable bodies:
   2.1. Hook's law, Young modulus, bulk modulus, modulus of rigidity, & Poisson ratio, relationship between various elastic moduli.
   2.2. Possible values of Poisson's ratio, finding Poisson's ratio of rubber in the laboratory, torsion of a cylinder, strain energy of twisted cylinder.
   2.3. Finding the modulus of rigidity of the material of a wire by Barton's method, torsional pendulum and Maxwell's needle, Searl's method to find Y, η, & σ of the material of a wire, bending of beam, beam supported at its ends and loaded in the middle.

Keywords/Tags: Rigid body, Center of mass, Moment of inertia, Poisson's ratio.

Unit II: Fluid mechanics (No. of Lectures: 12):

1. **Surface tension:**
   - 1.1. Inter-molecular forces and potential energy curve, force of cohesion & adhesion.
   - 1.2. Surface tension, explanation of surface tension on the basis of intermolecular forces, surface energy, effect of temperature and impurities on surface tension, daily life application of surface tension.
   - 1.3. Angle of contact, the pressure difference between the two sides of curved liquid surface, excess pressure inside a soap bubble, capillarity, determination of surface tension of liquid – capillary rise method, Jaeger's method.
2. **Viscosity:**
   - 2.1. Ideal and viscous fluid, streamline and turbulent flow, equation of continuity, rotational and irrotational flow, energy of a flowing fluid, Euler's equation of motion of a non-viscous fluid and its physical significance.
   - 2.2. Bernoulli's theorem and its applications (velocity of efflux, shapes of wings of airplanes, Magnus effect, filter pump, Bunsen's burner).
   - 2.3. Viscous flow of a fluid, flow of liquid through a capillary tube, derivation of Poiseuille's formula and limitations, Stokes formula, motion of a spherical body falling in a viscous fluid, air resistance/drag, motion of parachute through air.

Unit IV: Gravitational potential and central forces (No. of Lectures: 12):

1. **Gravitational potential:**
   - 1.1. Conservative & non-conservative force field, conservation of energy in motion under the conservative and non-conservative forces, potential energy.
   - 1.2. Conservative force, conservation of energy, gravitational potential and intensity of gravitational field due to a uniform spherical shell and a uniform solid sphere.
   - 1.3. Gravitational self-energy, gravitational self-energy of a uniform spherical shell and a uniform solid sphere.
2. **Central forces:**
   - 2.1. Motion under central forces, conservative characteristics of central forces.
   - 2.2. The motion of a two particle system in central force, concept of reduced mass, reduced mass of positronium and hydrogen.
   - 2.3. Motion of particles in an inverse-square central force, motion of celestial bodies and derivation of Kepler's laws.
   - 2.4. Elastic & inelastic scattering (elementary idea).

Keywords/Tags: Conservative force field, Gravitational potential, Gravitational self-energy, Central force, Reduced mass, Scattering.

Unit V: Relativistic Mechanics and Astrophysics (No. of Lectures: 12):

1. **Relativistic Mechanics:**
   - 1.1. Frame of references, Galilean transformation, Michelson-Morley experiment.
   - 1.2. Postulates of special theory of relativity, Lorentz transformation, simultaneity and order of events, length contraction, time dilation, relativistic transformation of velocities, variation of mass with velocity.
   - 1.3. Mass-energy equivalence and its experimental verification.
2. **Astrophysics:**
   - 2.1. Introduction to the Universe, properties of the Sun, concept of astronomical distance.

2.2. Life cycle of a star, Chandrasekhar limit, H-R diagram, red giant star, white dwarf star, neutron star, black hole.
2.3. Big bang theory (elementary idea).

Keywords/Tags: Transformation, Mass-energy equivalence, Astronomical distance, Chandrasekhar limit, Black hole.

Part C- Learning Resources

Text Books:

1. M.R. Spiegel, Vector Analysis: Schaum Outline Series, McGraw Hill Education, 2017.
2. D.S. Mathur Mechanics, S. Chand, 2012.
3. A.K.Ghatak, I.C. Goyal, and S.J. Chua, Mathematical Physics, Laxmi Publication Private Limited, 2017.
4. D.S. Mathur D.S., Properties of Matter, Shyamlal Charitable Trust, New Delhi.
5. Sears and Zeemansky, University Physics, Pearson Education.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks [Class Interaction/Quiz – 15 marks; Attendance – 05 marks; Assignments (Charts/Model/Seminar/Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey/ Industrial visit) – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Viva-voce on Practical – 10 marks; Practical Record File – 10 marks; Table work/Experiments – 50 marks.]

Course Title: Mechanics and General Properties of Matter Lab.

Part A - Introduction

Course Code: UPHYS102
Course Type: Major Core Course for Physics Major students/Minor Course for Mathematics Major & Generic Elective for Chemistry Major students (practical).
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Physics in 12^{th} class.
Course Learning Outcomes (CLO):
1. The students would acquire basic practical knowledge related to mechanics through the experiments.
2. Students will be familiar with various measurement devices by which they can measure various physical quantities with accuracy..
3. The students will develop the concept related to the mechanics and properties of matter.

Part B – Content of the Course [Total number of practical (in hours): 60]

List of experiments
1. Determination of Young's modulus, modulus of rigidity and Poisson's ratio of material of a wire using Searl's method.
2. Determination of Young's modulus of material of a metallic bar by bending of beam method.

3. Determination of acceleration due to gravity (g) by free fall method.
4. Determination of acceleration due to gravity (g) using bar pendulum/Kater's double pendulum.
5. Determination of modulus of rigidity of a rod with the help of Barton's apparatus.
6. Determination of coefficient of viscosity of liquid using Poiseuille's method.
7. Determination of the moment of inertia of a flywheel about its axis of rotation.
8. Determination of moment of inertia of a given body (irregular body) with the help of inertia table.
9. Verification of laws of the parallel/perpendicular axes of moment of inertia.
10. Determination of moment of inertia of a given body (irregular body) with the help of Maxwell's needle.
11. Determination of Young's modulus of material of a rod using cantilever method.
12. Determination of modulus of rigidity of material of a wire with the help of torsional pendulum.
13. Determination of force constant of a spring
14. Determination of Poisson's ratio of a rubber.
15. Determination of surface tension of a liquid by Jaeger's method.
16. Determination of static & dynamic friction.
17. Determination of elastic and inelastic collisions, momentum, and Newton's laws of motion.

Part C- Learning Resources

Text books:

1. I. Prakash & Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, 2011, 11/e.
1. G.L. Squires, Practical Physics, Cambridge University Press, 2015, 4/e.
2. B.L. Flint and H.T. Worsnop, Advanced Practical Physics for Students, Asia Publishing House.
3. D. Chattopadhyay & P.C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency.

Part D – Assessment and Evaluation

A. Internal Assessment: Continuous Comprehensive Evaluation (CCE): 30 marks [Class Interaction/Quiz – 15 marks.; Attendance – 05 marks; Assignments (Charts/Model/Seminar/Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey/ Industrial visit) – 10 marks.]

B. External Assessment: University Exam (UE): 70 marks [Time: 03.00 hours; Viva-voce on Practical – 10 marks; Practical Record File – 10 marks; Table work/Experiments – 50 marks.]

Course Title: Thermodynamics and Statistical Mechanics

Part A - Introduction

Course Code: UPHYS103

Course Title: Thermodynamics and Statistical Mechanics

Credit value: 4

Total Marks: 30 + 70 = 100; Min. Passing Marks: 35

Pre-requisite (if any): To study this course, a student must have had the subject Physics in 12^{th} class.

Course Learning Outcomes (CLO):

1. The course would enable the students to understand the basic Physics of heat & temperature in relation to energy, work, radiation, & matter.
2. The students are expected to learn that "how laws of thermodynamics are used in a heat engine to transform heat into work".
3. This course will also develop an understanding of the various concepts of statistics and the methods to apply them in thermodynamics.
4. Students will understand the importance of studying statistical mechanics with the behavior of particles under classical and quantum conditions.

Part B – Content of the Course

Unit I: Historical background & Laws of thermodynamics (No. of Lectures: 12):

1. **Historical background:** A brief historical background of thermodynamics and statistical physics in the context of India and Indian culture, contribution of S.N. Bose in statistical physics.
2. **Laws of thermodynamics:**
   2.1. Thermodynamical system & thermodynamical coordinates, thermal equilibrium, Zeroth law of thermodynamics, concept of path function and point function, work done by & on the system.
   2.2. First law of thermodynamics, internal energy as a state function, reversible & irreversible change, heat engine & its efficiency, Carnot's cycle, Carnot's engine & its efficiency, Carnot's theorem, Otto cycle, diesel engine.
   2.3. Second law of thermodynamics, statement of Kelvin-Planck & Clapeyron, absolute scale of temperature: zero of absolute scale, size of degree, identity of a perfect gas scale & absolute scale.

Keywords/Tags: Thermodynamics, Internal energy, Heat engine, Absolute scale.

Unit II: Entropy (No. of Lectures: 12):

1. Concept of entropy, Clausius theorem, entropy as a point function, change in entropy in reversible and irreversible processes.
2. Change of entropy of an ideal gas, change of entropy when two liquids at different temperatures are mixed (or two bodies at different temperatures are kept in contact).
3. Principle of increase of entropy, change in entropy of the universe in an irreversible process, disorder & heat death of universe.
4. Physical significance of entropy, Temperature-Entropy (T-S) diagram, third law of thermodynamics.

Keywords/Tags: Reversible process, Entropy, Ideal gas.

Unit III: Thermodynamic potential and kinetic theory of gases (No. of Lectures: 12):

1. **Thermodynamic potential and its application:**
   1.1. Thermodynamic potentials, thermal equilibrium, internal energy, Helmholtz free energy, Enthalpy & Gibbs free energy.
   1.2. Derivation of Maxwell's relations from thermodynamic potentials, Gibbs-Helmholtz equation, thermodynamic energy equation for ideal and van der Waal gas.
   1.3. TdS equation, derivation of expression for C_P-C_V and their specific cases for ideal and van der Waal gases, derivation of the expression C_P/C_V.
   1.4. Clausius-Clapeyron latent heat equation, temperature change in adiabatic process, principle of refrigeration, Joule-Thomson effect, cooling by adiabatic demagnetization, production & measurement of very low temperature.

2. **Kinetic theory of gases:**
   2.1. Behavior of a real gas and its deviation from an ideal gas, Virial equation, Andrew's experiment on CO_2 gas.
   2.2. Critical constant, continuity of the liquid and gaseous state, vapor and gas state, Boyle temperature, van der Waal's equation for real gas, values of critical constants, law of the corresponding state.

Keywords/Tags: Potential, Enthalpy, Adiabatic, Real gas, Critical constant

Unit IV: Classical Statistics (No. of Lectures: 12):

1. Probability, distribution of N particles in two identical boxes, probability of occurrence of either event, probability of composite events, weightage probability.
2. Probability distribution and its narrowing with the increase in number of particles, expression for average properties constraints, accessible and non-accessible microstates.
3. Ensemble theory (micro-canonical, canonical and grand-canonical), macro and micro states with examples, ensemble average & time average, principle of equal a priori probability, Ergodic hypothesis, concept of phase space, μ- and γ-space, degree of freedom, generalized coordinates.
4. Boltzmann canonical distribution law: Application: Average energy of one-dimensional harmonic oscillator.
5. Derivation of law of equipartition of energy from statistics, equilibrium between two system in thermal contact and β parameter, statistical interpretation of entropy and relation $S = k \log \Omega$.
6. Boltzmann partition function and derivation of expression for internal energy, Helmholtz free energy, enthalpy and Gibb's free energy.

Keywords/Tags: Probability, Microstate, Ensemble theory, Partition function.

Unit V: Quantum Statistics (No. of Lectures: 12):

1. Indistinguishability of particles and its consequences, Maxwell-Boltzmann statistics (classical statistics): Maxwell-Boltzmann distribution law of velocity and speed, Maxwell-Boltzmann statistics and its distribution law.
2. Quantum statistics: Bose-Einstein statistics and distribution law, derivation of Planck's law from B-E statistics, Rayleigh-Jeans law, Wien's displacement law, and Stefan's law.
3. Fermi-Dirac statistics and its distribution law, explanation of free electron theory, Fermi level and Fermi energy.
4. Comparison between Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.

Keywords/Tags: Indistinguishability, Velocity distribution, Fermi level.

Part C - Learning Resources

Text books:

1. M.W. Zemansky & R. Dittman, Heat and Thermodynamics, Tata McGraw-Hill.
2. Sears & Salinger, Thermodynamics, Kinetic Theory, & Statistical Thermodynamics, Narosa.
3. S.C. Garg & C.K. Ghosh, Thermal Physics, Tata McGraw-Hill.
4. N. Subrahmanyam, Brij Lal, P.S. Hemne, Heat, Thermodynamics, & Statistical Mechanics, S. Chand, 2012.

Part D – Assessment and Evaluation

A. Internal evaluation/Continuous Comprehensive Evaluation (CCE): 30 marks [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External/University Exam (UE): 70 marks [Time: 3 hours; Question pattern: As per Bloom's taxonomy.]

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Course Title: Thermodynamics and Statistical Mechanics Lab.

Part A - Introduction

Course Code: UPHYS104
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Physics in 12^{th} class
Course Learning Outcomes (CLO):

1. The students would gain practical knowledge about heat and radiation by performing various experiments.
2. The students will acquire knowledge about the different forms of distribution of subatomic particle in the system using statistical methods.
3. The students will be able to use various thermodynamical instruments in daily life.

Part B – Content of the Course [Total number of practical (in hours) - 60]:

List of experiments

1. Determination of mechanical equivalent of heat by Callendar & Barne's method.
2. Determination of efficiency of electrical kettle with variable voltages.
3. Determination of temperature coefficient of a resistance using platinum resistance thermometer.
4. Determination of electromotive force of a thermocouple.
5. Determination of thermal conductivity of a bad conductor by Lee's disc method.
6. Verification of Newton's law of cooling.
7. Determination of the ratio of specific heat of air by Clement-Desome's method.
8. Determination of the specific heat of liquid with the help of Newton's law of cooling.
9. Determination of the coefficient of thermal conductivity of a metal by Searl's method.
10. Determination of thermal conductivity of the rubber using calorimeter.
11. Determination of mechanical equivalent of het (J) using Joule calorimeter.
12. Determination of Stefan's constant using thermocouple.
13. Study of statistical distribution and determination of standard deviation with the help of black and white dice.
14. Determination of the temperature coefficient of a resistance with the help of Carey-Foster bridge.
15. Determination of the critical constant of a gas/vapour.

Part C- Learning Resources

Text books:

2. I. Prakash & Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, 2011, 11/e.
4. G.L. Squires, Practical Physics, Cambridge University Press, 2015, 4/e.
5. B.L. Flint and H.T. Worsnop, Advanced Practical Physics for Students, Asia Publishing House.
6. D. Chattopadhyay & P.C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency.

Part D – Assessment and Evaluation

A. Internal Assessment: Continuous Comprehensive Evaluation (CCE): 30 marks [Class Interaction/Quiz – 15 marks; Attendance – 05 marks; Assignments (Charts/Model/Seminar/Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey/ Industrial visit) – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Viva-voce on Practical – 10 marks; Practical Record File – 10 marks; Table work/Experiments – 50 marks.]

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Subject: Mathematics

Course Title: Algebra, Vector Analysis and Geometry

Part A - Introduction

Course Code: UMATH101
Course Title: Algebra, Vector Analysis and Geometry
Credit value: 6
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Mathematics in class 12^{th}.
Course Learning Outcomes (CLO): The course will enable the students to:

1. Recognize consistent and inconsistent systems of linear equations by the row echelon form of augmented matrix, using the rank of matrix.
2. To find the Eigen values and corresponding Eigen vectors for a square matrix.
3. Using the knowledge of vector calculus in geometry.
4. Enhance the knowledge of three dimensional geometrical figures (e.g., cone and cylinder).

Part B - Content of the Course
Total No. of Lectures (in hours per week): 3 hours per week; Total Lectures: 90 hours.

Unit I: (No. of Lectures: 15):

1. Historical background:
   1.1. Development of Indian Mathematics: Later classical period (500 – 1250).
   1.2. A brief biography of Varahmihira and Aryabhatta.
2. Rank of a matrix.
3. Echelon and normal form of a matrix.
4. Characteristic equations of a matrix
   4.1. Eigen-values
   4.2. Eigen-vectors.

Unit II: (No. of Lectures: 18):

1. Cayley Hamilton theorem.
2. Application of Cayley Hamilton theorem to find the inverse of a matrix.
3. Application of matrix to solve a system of linear equations.
4. Theorems on consistency and inconsistency of a system of linear equations.
5. Solving linear equations up to three unknowns.

Unit III: (No. of Lectures: 18):

1. Scalar and vector products of three and four vectors.
2. Reciprocal vectors.
3. Vector differentiation:
   3.1. Rules of differentiation.
   3.2. Derivative of triple products.

4. Gradient, divergence, and curl.
5. Directional derivatives.
6. Vector identities.
7. Vector equations.

Unit IV: (No. of Lectures: 15):

1. Vector integration.
2. Gauss theorem (without proof) and problems based on it.
3. Green theorem (without proof) and problems based on it.
4. Stoke theorem (without proof) and problems based on it.

Unit V: (No. of Lectures: 24):

1. General equation of second degree.
2. Tracing of conics.
3. System of conics.
4. Cone
   - 4.1. Equation of cone with given base.
   - 4.2. Generators of cone.
   - 4.3. Condition for three mutually perpendicular generators.
5. Cylinder
   - 5.1. Equation of cylinder and its properties.
   - 5.2. Right circular cylinder.
   - 5.3. Enveloping cylinder.

Keywords: Indian mathematics, Rank of a matrix, Scalar and vector products, Vector differentiation, Vector identities, Vector integration, General equation of second degree, Tracing of conics, System of conics, Equation of cone, Equation of cylinder.

Part C- Learning Resources

Text books:

1. K.B. Datta, Matrix and Linear Algebra, Prentice Hall of india Pvt. Ltd. New Delhi 2000.
2. Shanti Narayan, A Text Book of Vector Calculus, S. Chand 7 Co., New Delhi, 1987.
3. S.L. Loney, The Elements of Coordinate Geometry part – 1, New Age International (P) Ltd. Publishers, New Delhi, 1999.
4. P.K. Jain and Khalil Ahmad, A text book of Analytical Geometry of Three Dimensions, Wiley Eastern Ltd., 1999.
5. Gerard, G. Emch, R. Sridharan, M.D. Srinivas, Contributions to the History of Indian Mathematics, Hindustan Book Agency, Vol. 3, 2005.

Reference books:

1. Chandrika Prasad, A Text Book on Algebra and Theory of Equations, Pothisala Pvt. Ltd., Allahabad, 2017.
2. N. Jocobson, Basic Algebra, Vol. I and Vol. II, W.H. Freeman, 2009.
3. I.S. Luther and I.B.S. Passi, Algebra Vol. I and II, Narosa Publishing House, 1997.
4. N. Saran and S.N. Nigam, Introduction to Vector Analysis, Pothishala Pvt. Ltd. Allahabad, 1990.
5. M.R. Spiegel, Vector Analysis, Schaum Publishing Company, 2017.
6. Gorakh Prasad and H.C. Gupta, Text Book on Coordinate Geometry, Pothishala Pvt. Ltd. Allahabad, 2000.

7. P.K. Jain and Khalil Ahmad, A text book of Analytical Geometry of Two Dimensions, Macmillan Indian Ltd., 1994.
8. N. Saran and D.N. Gupta, Three Dimensional Coordinate Geometry, Pothishala Pvt. Ltd. Allahabad, 1994.
9. R.J.T. Bell, Elementary Treatise on coordinate Geometry of Three Dimensions, Macmillan India Ltd., 194.
10. Bibhutibhusan Datta and Avadesh Narayan Singh, History of Hindu Mathematics, Asia Publishing house, 1962.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Question: As per Bloom's taxonomy.]

Course Title: Calculus and Differential Equations

Part A - Introduction

Course Code: UMATH102
Course Title: Calculus and Differential Equations
Credit value: 6
Total Marks: 30 + 70 = 100; **Min. Passing Marks:** 35
Pre-requisite (if any): To study this course, a student must have had the subject Mathematics in class 12^{th}.
Course Learning Outcomes (CLO): The course will enable the students to:
1. Sketch curves in a plane using its Mathematical properties in the different coordinate systems of reference.
2. Using the derivatives in optimization, social sciences, physics and life sciences etc.
3. Formulate the differential equations for various Mathematical models.
4. Using techniques to solve and analyze various Mathematical models.

Part B: Content of the course [Total no. of lectures (in hours per week); 3 hours per week. Total lecture: 90 hours]

Unit I: (No. of lectures: 18):
1. **Historical background:**
   1.1. Development of Indian mathematics: Ancient and Early Classical Period (till 500 CE).
   1.2. A brief biography of Bhāskaracharya (with special reference to Lilavati) and Madhava.
2. **Successive differentiation**
   2.1. Leibnitz theorem.
   2.2. Maclaurin's series expansion.
   2.3. Taylor series expansion.

3. **Partial Differentiation**
   3.1. Partial derivatives of higher order.
   3.2. Euler theorem on homogeneous functions.
4. **Asymptotes**
   4.1. Asymptotes of algebraic curves.
   4.2. Condition for existence of asymptotes.
   4.3. Parallel asymptotes.
   4.4. Asymptotes of polar curves.

Unit II: (No. of lectures: 18):

1. Curvature
   1.1.Formula for radius of Curvature.
   1.2.Curvature at origin.
   1.3.Center of Curvature.
2. **Concavity and Convexity**
   2.1.Concavity and convexity of curves.
   2.2.Point of inflection.
   2.3.Singular point.
   2.4.Multiple points.
3. **Tracing of Curves**
   3.1. Curves represented by Cartesian equation.
   3.2.Curves represented by Polar equation.

Unit III: (No. of lectures: 18):

1. Integration of transcendental functions.
2. Introduction to double and triple integral.
3. Reduction formulae.
4. Quadrature
   4.1. For Cartesian coordinates.
   4.2. For Polar coordinates.

Unit IV: (No. of lectures: 18):

1. Linear differential equations.
   1.1. Linear equation.
   1.2. Equations reducible to the linear form.
   1.3. Change of variables.
2. Exact differential equations
3. First order and higher degree differential equations.
   3.1. Equations solvable for x, y, and p.
   3.2. Equations homogeneous in x and y.
   3.3. Clairaut's equation.
   3.4. Singular solutions.
   3.5. Geometrical meaning of differential equations.
   3.6. Orthogonal trajectories.

Unit V: (No. of lectures: 18):

1. Linear differential equations with constant coefficients.
2. Homogeneous linear ordinary differential equations.

3. Linear differential equations of second order.
4. Transformation of equations by changing the dependent/independent variable.
5. Method of variation of parameters.

Keywords/Tags: Indian mathematics, Successive differentiation, Partial differentiation, Asymptotes, Curvature, Tracing of curves, Quadrature, Rectification, Linear differential equations, Method of variation of parameters.

Part C- Learning Resources

Text books:

1. Gorakh Prasad: Differential Calculus, Pothishala Private Ltd., Allahabad, 2016.
2. Gorakh Prasad: Integral Calculus, Pothishala Private Ltd., Allahabad, 2015.
3. M.D. Raisinghania: Ordinary and Partial Differential Equations, S. Chand 7 Co. Ltd., 2017.
4. Gerard G. Emch, R. Sridharan and M.D. Srinivas: Conrtibutions to the Histroy of Indian Mathematics, Hindustan Book Agency, Vol. 3, 2005.

Reference books:

1. N. Piskunov, Differential and Integral Calculus, CBS Publishers, 1996.
2. G.F. Simmons, Differential Equations, Tata McGraw Hill, 1972.
3. E.A. Codington,An Introduction to ordinary differential Equations, Orient Longman (India),1961.
4. D.A. Murray, Introductory Course in Differential Equations and their Application, C.B.S. Publisher & Distributors, Delhi, 1985.
5. H.T.H. Piaggio, Elementary Treatise on Differentia Equations and their Application, C.B.S. Publisher & Distributors, Delhi, 1985.
6. Gorakh Prasad and H.C. Gupta, Text Book on Coordinate Geometry, Pothishala Pvt. Ltd.
7. Bibhutibhusan Datta and Avadesh Narayan Singh: History of Hindu Mathematics, Asia Publishing House, 1962.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks) [Time: 03.00 hours; Question: As per Bloom's taxonomy.]

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Subject: Chemistry

Course Title: Fundamentals of Chemistry

Part A - Introduction

Course Code: UCHEM101
Course Title: Fundamentals of Chemistry
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Chemistry in class 12^{th}.
Course Learning Outcomes (CLO): By the end of this course students will learn the following aspects of Chemistry:

1. Ancient Indian chemical techniques.
2. Various theories and principles applied to reveal atomic structure.
3. Significance of quantum numbers.
4. Concept of periodic properties of elements.
5. Theories related to chemical bonding.
6. Acid-base concept, pH, buffer.
7. Factors responsible for reactivity of organic molecules.
8. Basics and mechanism of chemical kinetics.
9. Properties of electrolytes.

Part B – Content of the course

Unit I: (No. of lectures: 06):

1. **Chemical techniques in ancient India:** General introduction.
2. Contribution of ancient Indian scientists in chemistry, e.g., metallurgy, dyes, pigments, cosmetics, ayurveda, Charak Sanhita.
3. **Atomic structure:**
   - 3.1. Review of Bohr's theory and its limitations, atomic spectrum of hydrogen, dual nature of particles and waves, de Broglie's equation, Heisenberg's uncertainty principle and its significance.
   - 3.2. Quantum numbers and their significance, rules for filling electrons in various orbitals, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, variation of orbital energy with atomic number.
   - 3.3. Electronic configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.

Keywords/Tags: Metallurgy, Dyes, Cosmetics, Charak Samhita, Hydrogen spectrum, Hund's rule, Aufbau principle.

Unit II: (No. of lectures: 06):

1. Elementary idea of the following properties of the elements with reference to s and p-block elements in periodic table

1.1. Effective nuclear number (EAN), shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
1.2. Atomic radii (van der Waals).
1.3. Ionic and crystal radii.
1.4. Covalent radii (octahedral and tetrahedral).

2. Detailed discussion of the following properties of the elements with reference to s and p-block elements in periodic table
   2.1. Ionization energy – successive ionization energy and factors affecting ionization energy, applications of ionization energy.
   2.2. Electronegativity – Pauling's/Mulliken's electronegativity scales, variation of electronegativity with bond order, partial charge, hybridization.

Keywords/Tags: EAN, Atomic radii, Ionic radii, Crystal radii, ionization energy.

Unit III: (No. of lectures: 20):

1. Chemical bonding:

1. Ionic bonding - general characteristics of ionic bonding.
2. Ionic bonding and energy – lattice & salvation energies and their importance in the context of stability and solubility of ionic compounds.
3. Statement of Born-Landé equation for calculation of lattice energy, Madelung constant, Born-haber cycle and its applications, covalent character in ionic compounds, polarizing power and polarizability, Fajan's rule.
4. Covalent bonding: Lewis structure, valence band theory (Heitler-London approach).
5. Hybridization: Concept, types (sp, sp^2, sp^3, dsp^2, d^2sp^3) with suitable examples of inorganic and organic molecules.
6. Ionic character in covalent compounds – dipole moment and percentage ionic character.
7. Valence shell electron pair repulsion theory (VSEPR) – assumptions, need of theory, application of theory to explain geometries or shapes of some inorganic molecules and ions on the basis of VSPER and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements such as NH_3, H_2O, SF_4, PCl_5, SF_6, ClF_5, XeF_4.

2. Molecular Orbital (MO) concept of bonding:

1. The approximation of the theory, linear combination of atomic orbitals (LCAO) (elementary pictorial approach).
2. Rules for the LCAO method, bonding and antibonding MOs, characteristics for s-s, s-p, and p-p combinations of atomic orbitals, nonbonding of orbitals.
3. MO diagrams of homonuclear diatomic molecules: H_2, Li_2, Be_2, C_2, N_2, O_2, F_2, and their ions.
4. Molecular orbitals of heterogeneous diatomic molecules: CO, NO, CN, HF.
5. Bond parameters: Definition and factors affecting – bond orders, bond lengths, bond angles.

Keywords/Tags: ionic bonding, Covalent bonding, Hybridization, VSEPR theory, LCAO, MO diagrams, bond parameters.

Unit IV: Acid base concept (No. of lectures: 4):

1. Arrhenius concept, Bronsted-Lowry's concept, conjugate acids and bases, relative strength of acids, Lewis concept, pH, buffer solutions, acid-base neutralization curves, Handerson equation.
2. Strength of organic acids and bases: Comparative study with emphasis on factor pH values.

3. Indicator, choice of indicator.

Keywords/Tags: Acid-base concept, Bronsted-Lowry concept, Conjugate acids and bases, pH, Buffer solution, indicator.

Unit V: (No. of lectures: 12):

1. **Fundamentals of organic chemistry:** Structure, shape and reactivity of organic molecules, physical effects, electronic displacement, inductive effect, electrometric effect, resonance and hyperconjugation, cleavage of bonds – homolysis and heterolysis, reactive intermediates – carbocations, carboanions and free radicals, nucleophiles and electrophiles.

2. **Stereochemistry of organic compounds:**
   1. Geometrical isomerism – Determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.
   2. Optical isomerism – Elements of symmetry, molecular chirality, enantiomers & their properties, stereogeniccenter, optical activity of enantiomers, concept of chirality (up to two carbon atoms) – chiral and achiral molecules with two stereogeniccenters, diastereomers, threo and erythroisomers, mesoisomer, resolution of enantiomers, invesion, retention and racemization, relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature.
   3. Conformations and Conformational Analysis: Conformationa of ethane, butane, and cyclohexane, interconversion of Wedge formula, Newman, Sawhorsw and Fischer representations.

Keywords/Tags: Electronic displacements, Nucleophiles, Electrophiles, Isomerism, Molecular Chirality, Enantiomers, Sequence rules, Conformation.

Unit VI (No. of lectures: 12):

1. **Chemical kinetics:** Rate of reaction, definition and difference of order and molecularity, derivation of rate constants for first, second, third, and zero order reactions and examples, derivation for half-life period, methods to determine the order of reactions, effect of temperature on rate reaction, Arrhenius equation, concept of activation energy.

2. **Ionic equlibria:** Strong, moderate, and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, common effect, salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts, solubility and solubility product of sparingly soluble salts – applications of solubility product.

Keywords/Tags: Order of reaction, molecularity of reaction, Arrhenius equation, Activation energy, Electrolytes, Salt hydrolysis, Solubility product.

Part C- Learning Resources

Text books:

1. J.D. Lee, Concise Inorganic Chemistry, ELBS, 1991.
2. H.C. Khera, J.N. Gurtu, J. Singh, Chemistry of B.Sc. 1st Year, Pragati Prakashan.
3. A. Bariya & S. Goyal, B.Sc. Chemistry Combined (in Hindi), Krishna Educational Publishers, 2019.

4. B.R. Puri, M.S. Pathania, L.R. Sharma, Principles of Physical Chemistry, Vishal Publishing Co., 2020.
5. J.N. Gurtu and A. Gurtu, Advanced Physical Chemistry, Pragati Prakashan, Meerut, ISBN: 9789386633347, Edition IV, 2017.
6. M.C. day and J. Selbian, Theoretical Inorganic Chemistry, ACS Publications, 1962.
7. A. Bahl & B.S. Bahl, Advanced Organic Chemistry, S. Chand, 2010.
8. P.S. Kalsi, Stereochemistry Conformation and Mechanism, New Age International 2005.
9. I.L. Finar, Organic Chemistry (Vol. I & II), ELBS.
10. R.T. Morrison and R.N. Boyd, Organic Chemistry, Pearson, 2010.
11. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2nd edition, 2012.
12. Atkin's Physical Chemistry, 10th edtion, Oxford University Press, 2014.

Reference books:

1. S. Prakash, Founders of Sciences in Ancient India, published by the Research Institute of Ancient Scientific Studies, New Delhi.
2. Acharya Prafulla Chandra Ray – A Collection of Writing, Vol. IIIA: A History of Hindu Chemistry (Vol. 1), Editor- Prof. Anil Bhattacharyya. Publisher: University of Calcutta.
3. Chemistry in India, in Tradition and Practices of India, Textbook for Class XI, module 2, Central Board of Secondary Education.
4. J.E. Huheey, E.A. Keiter, R.L. Keiter, & O.K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. B.E. Douglas, D.H. McDaniel, & J.J. Alexander, Concepts and Models in Inorganic Chemistry, John Wiley & Sons, 1994.
6. T.W. Graham Solomom, C.B. Fryhle, & S.A. Dnyder, Organic Chemistry, John Wiley & Sons, 12th Edition, 2016.
7. J.E. McMurry, Fundamentals of Organic Chemistry, Cengage Learning India Edition, 2013.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks) [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks) [Time: 03.00 hours; Question: As per Bloom's taxonomy.]

Course Title: Qualitative & Quantitative Chemical Analysis Lab.

Part-A: Introduction

Course Code: UCHEM102
Course Title: Qualitative & Quantitative Chemical Analysis Practical
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Chemistry in class 12^{th}.
Course Learning Outcomes (CLO): By the end of this course students will learn the following aspects of Laboratory exercises in Chemistry:

1. Importance of chemical safety and lab safety while performing experiments in laboratory.
2. Qualitative inorganic analysis.
3. Elemental analysis of organic compounds (non-instrumental).
4. Qualitative identification of functional group of organic compounds.
5. Techniques of pH measurements.
6. Preparation of buffer solutions.

Part-B: Content of the course

Unit I: Qualitative inorganic analysis: Identification of simple inorganic mixture (5 radicals) with two/three acidic and two/three basic radicals (including typical combinations), special emphasis on learning theoretical concepts of strong, moderate, and weak electrolysis, ionic product, common ion effect, solubility and solubility product.

Unit II: Qualitative organic analysis:

1. Detection of hetero-elements (N,S, Cl, Br, I) in organic compounds.
2. Functional group tests for alcohol, aldehyde, carboxylic acid, carbohydrate, phenols, nitro, amine, and amide.

Quantitative analysis of acid, alkali, and buffer solutions

Ionic Equilibria

1. Measurement of pH of different solutions of acids and alkalies using pH-meter (may use aerated drinks, fruit juices, shampoos, and soaps).

Note – use dilute solutions of soaps and shampoos to prevent damage to the glass electrode.

2. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.
3. Preparation of buffer solutions and determination of their pH and buffer capacity:
    a) Sodium acetate-acetic acid
    b) Ammonium chloride-ammonium hydroxide.

Part C- Learning Resources

Text Books:

1. A.K. Goswami, A. Mehta, O.R.S Khanna Rehana, UGC Practical Chemistry, Vol. 1, Pragati Prakashan, 2015.
2. S. Goyal, B.Sc. Chemistry Practical, Krishna Publications, 2017.
3. J. Mendham, Vogel's Quantitative Inorganic Analysis, Pearson Education, 2012.

References:

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, Practical Organic Chemistry, Pearson, 2012.
2. Prof. Robert H. Hill Jr., David C. Finster, laboratory Safety for Chemistry Students, Wiley, 2016.

Part D – Assessment and Evaluation

A. Internal Assessment: 30 marks

I. Class interaction: Chemical and lab Safety (15 marks)
   1. Toxicity of the compounds used in chemistry laboratory.
   2. Safety symbols on labels of pack of chemicals and its meaning.
   3. What is MSDS sheet? Find out MSDS sheets of some hazardous chemicals ($K_2Cr_2O_7$, benzene, cadmium nitrate, sodium metals, etc.)
   4. Precautions in handling and storage of hazardous substances like concentrated acids, ammonia, organic solvents, etc.

NOTE: Description to be written in practical record.

II. Attendance: 5 marks.

III. Assignments (Charts/Model seminar/rural service/technology dissemination/report of excursion/lab visits/survey/industrial visit): 10 marks

B. External Assessment: 70 marks [Time: 3 hours; Viva voce on practical: 10 marks; Practical Record File: 10 marks; Table work/Experiments: 50 marks.]

Course Title: Analytical Chemistry

Part-A: Introduction

Course Code: UCHEM103
Course Title: Analytical Chemistry
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Course Learning Outcomes (CLO): By the end of this course students will learn the following aspects of chemistry:

1. Basic concepts of mathematics for chemists.
2. Fundamentals of analytical chemistry and steps involved in analysis.
3. Basic knowledge of computer for chemists.

4. Basic concepts of chemical equilibrium.
5. Principles f chromatography and chromatographic techniques.
6. Various techniques of spectroscopic analysis.

Part B – Content of the course

Unit I: Mathematics for Chemists (No. of lectures: 10): Straight line equation. Logarithmic relations, curve sketching, linear graphs & calculation of slopes, differentiation, differentiation of functions like e^x, x^n, sinx, log x, maxima & minima, partial differentiation, integration of some useful relevant functions.

Keywords/Tags: Linear graphs, Logarithmic relation, Differentiation, Integration.

Unit II: Basic Analytical Chemistry (No of lectures: 10): Introduction to analytical chemistry and its interdisciplinary nature, concept of sampling, importance of accuracy, precision and sources of error in analytical measurements, presentation of experimental data and results, from the point of view of significant figures, statistical terms – mean, mean deviation, median, standard deviation, numerical problems.
Calculations used in Analytical Chemistry
Some Important units of measurements – SI units, distinction between mass and weight, mole, milli mole & numerical problems.
Solution and their concentrations – Empirical and molecular formulas, stoichiometric calculations, numerical problems.

Keywords/Tags: Accuracy, Precision, SI units, Units of concentration, Chemical stoichiometry.

Unit III: Computer for Chemists (No. of lectures: 10): Introduction to computer, introduction to operating systems like-DOS, Windows, Linux, and Ubuntu.
Use of computer programs – Running of standard programs & packages such as MW-word, MS-excel, Power Point, Execution of linear regression, x-y plot, use of software for drawing structures and molecular formulae.

Keywords/Tags: Operating system, MS-Word, MS-Excel, Power Point.

Unit IV: Chemical Equilibrium (No. of lectures: 10): Equilibrium constant and free energy, concept of chemical potential, thermodynamic derivation of law of chemical equilibrium, temperature dependence of equilibrium constraint, Van't Hoff reaction isochore, Van't Hoff reaction isotherm, Le-Chatelier's principle and its applications.

Keywords/Tags: Chemical equilibrium, Equilibrium constant, Free energy, Chemical potential.

Unit V: Chromatography (No. of lectures: 10): Introduction, principle and classification, mechanism of separation – adsorption, partition, and ion-exchange; development of chromatograms – frontal elution, and displacement methods; paper chromatography (ascending, descending, and circular), this layer

chromatography (TLC) and Column Chromatography (CC), Gas Chromatography (GC) and High Pressure Liquid Chromatography (HSPLC), types of column and column selection, applications limitation; Principles and applications of flash chromatography, ion-exchange chromatography, and chiral chromatography.

Unit VI: Spectral techniques of analysis (No. of lectures: 10)**:**

1. **Basics of absorption spectroscopy:** Electromagnetic radiation, spectral range, absorbance, absorptivity, molar absorptivity, fundamental laws of absorption, Lambert-Beer law and its limitations, constitution and working of photometer, spectrometer, colorimeter.

2. **Ultraviolet (UV) absorption spectroscopy:** Presentation and analysis of UV spectra, types of electronic transitions, effects of conjugation, concept of chromophore and auxochrome, bathochromic, hypsochromic, hyperchromic and hpochromic shifts, UV spectra of conjugate polyenes and enones.

3. **Infra-red (IR) absorption spectroscopy**: Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, finger point region, characteristics absorption of various functional groups and interpretation of IR spectra of simple organic compounds.

Keywords/Tags: Hypsochromic, Hypochromic, Absorption, Spectrum

Part C- Learning Resources

Text books:

1. S. Gaur, Computer for Chemists, Neel Kamal Prakashan, 2017.
2. S.M. Khopkar, Basic Concepts of Analytical Chemistry, New Age International Publisher, 2009.
3. A. Bahl & B.S. Bahl, Advanced Organic Chemistry, S. Chand, 2010.
4. Y.R. Sharma, Elementary Organic Spectroscopy, S. Chand, 2013.

Reference Books:

1. G.M. Barrow, Physical Chemistry, Tata McGraw-Hill, 2007.
2. Banwell, Molecular Spectroscopy, 2017.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks) [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks) [Time: 03.00 hours; Question: As per Bloom's taxonomy.]

Course Title: Analytical Process and Techniques Lab.

Part A - Introduction

Course Code: UCHEM104
Course Title: Analytical Process & Techniques Practical
Credit value: 2
Total Marks: 30 + 70 = 100 Min. Passing Marks: 35
Course Learning Outcomes (CLO): By the end of this course students will learn the following aspects of Laboratory exercises in chemistry.

1. Concepts and analytical methods in chemistry.
2. Preparation of solutions of different concentrations.
3. Standardization of organic compounds by chromatographic techniques.
4. Analysis by spectral techniques.

Part B - Content of course

Experiments to be performed in laboratory

1. Basic analytical exercises:
    - Calibration of different weights and glass apparatus (measuring cylinder, burette, pipette, volumetric flasks.
        - Preparation of solutions of different molarity/normality by weighing and dilution.
2. Quantitative analysis: Titrimetric analysis
    - Standardization of NaOH with oxalic acid.
    - Determination of carbonate and hydroxide present in mixture.
    - Determination of carbonate and bicarbonate present in mixture.
    - Determination of free alkali present in different soaps/detergents.
3. Quantitative analysis by colorimetry:
    - Verification of Lambert-Beer law.
    - Determination of concentration of colored compounds (e.g., $CuSO_4$, $KMnO_4$).
4. Quantitative analysis:
    - Systematic identification of organic compound by qualitative analysis.
    - Chromatography: Identification of the R_f values of the given organic/inorganic compounds by paper/thin layer chromatography.

Keywords/Tags: Analytical, Authentication, Molarity/Normality, Standardization, Colorimetry, Qualitative analysis.

Part C- Learning Resources

Text books:

1. D.A. Skoog & J.J. Leary, Instrumental Methods of Analysis, Saunders College Publication, New York, 1992.
2. Vogel's textbook of quantitative chemical analysis.
3. Sudha Goyal, B.Sc. Chemistry Practical, Krishna Publication, 2017.

Part D – Assessment and Evaluation

A. Internal Assessment: 30 marks

I. Class interaction on: 15 marks.
   i. Common glassware and lab wares for solution preparation & analysis.
   ii. Numerical problems related to solution preparation.
   iii. Any other discussion.

NOTE: Description to be written in practical record.

II. Attendance: 5 marks.

III. Assignments (Charts/Model seminar/rural service/technology dissemination/report of excursion/lab visits/survey/industrial visit): 10 marks

B. External Assessment: 70 marks [Time: 3 hours; Viva voce on practical: 15 marks; Practical Record File: 15 marks; Table work/Experiments: 50 marks.]

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Subject: Zoology

Course Title: Animal Diversity: Non-Chordata

Part A - Introduction

Course Code: UZOOL101
Course Title: Animal Diversity: Non-Chordata
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course a student must have had the subject Biology in the 12th class.
Course Learning Outcomes (CLO): Upon completion of the course students should be able to

1. Learn about the importance of systemic, taxonomy and phylogeny to get a concrete idea of evolution of non-chordata phyla.
2. Understand the various morphological, anatomical structures and functions of animal of different phyla.
3. Get the knowledge about economic, ecological and medical significance of various animal in human welfare.
4. Understand the important parasites and their control measures.

Part B – Content of the Course

Unit I: Taxonomy, Phylogeny and Protozoa (No. of lectures: 11):

1. **Taxonomy:**
   1.1. Elementary knowledge of Zoological Nomenclature and International Code.
   1.2. Classification of Animal Kingdom upto Phylum of acoelomate and coelomate non-chordates according to Parker and Haswell 7th edition.
2. **Phylogeny:** Definitions and examples.
3. **Protozoa:**
   3.1. Phylum Protozoa: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   3.2. Structure, life history and pathogenicity of malarial parasite (*Plasmodium vivax*).
   3.3. Protozoa and disease.

Keywords/Tags: ICZN, Classification, Protozoa, *Plasmodium*.

Unit II: Porifera, Coelenterata (No. of lectures: 11):

1. **Porifera**
   1.1. Phylum Porifera: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   1.2. Type study of *Sycon*.
   1.3. Canal system of Sponges.

2. **Coelenterata**
   2.1. Phylum Coelenterata: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   2.2. ype study of *Obelia*.
   2.3. Coral and Coral reef formation.

Keywords/Tags: Classification, Porifera, *Sycon*, Coelentearata, *Obelia*, Coral reefs.

Unit III: Platyhelminthes, Nemathelminthes, Annelida (No. of lectures: 14):

1. Platyhelminthes
   1.1. Phylum Platyhelminthes: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   1.2. External morphology and life history of Liver fluke.

2. Nemathelminthes
   2.1. Phylum Nemathelminthes: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   2.2. Pathogenic symptoms of Nematodes and diseases.

3. Annelida
   3.1. Phylum Annelida: General charaters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   3.2. Type study of Earthworm (*Pheretima*).
   3.3. Structure and significance of Trochophore larva.

Keywords/Tags: Classification, Platyhelminthes, Liver fluke, Nematode disease, Annelida, *Pheretima*, Trochophore.

Unit IV: Arthropoda, Mollusca (No. of lectures: 12):

1. **Arthropoda**
   1.1. Phylum Arthropoda: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   1.2. Type study of Prawn.
   1.3. Larval forms of crustacean.
   1.4. Insects as a vector of human disease.
2. **Mollusca**
   2.1. Phylum Mollusca: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   2.2. Type study of *Pila*.
   2.3. Structure and Significance of Glochidium larva.

Keywords/Tags: Classification, Arthropoda, Prawn, Crustacea larva, Insects, Mollusca, *Pila*, Glocchidium.

Unit V: Echinodermata, Hemichordata (No. of lectures: 12):

1. **Echinodermata**
   - 1.1. Phylum Echinodermata: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   - 1.2. External features and water vascular system of Starfish (*Asterias*)
   - 1.3. Larval forms of Echinodermata.
2. **Hemichordata**
   - 2.1. Phylum Hemichordata: General characters of the phylum and outline classification up to classes with distinctive characters and suitable examples.
   - 2.2. Balanoglossus – External morphology.
   - 2.3. Structure and significance of Tornaria larva.

Keywords/Tags: Classification, Echinodermata, *Asterias*, Echinodermata larvae, Hemichordata, Balanoglossus, Tornaria.

Part C- Learning Resources

Text books:

1. J. Parker and W.A. Haswell, A Text Book of Zoology, 7th edition, Vol. I & II, Low Price Publications, Delhi, 1990.
2. R.D. Barnes, Invertebrate Zoology, 7th edition, Cengage learning, India, 2006.
3. J.A. Pechenik, Biology of the Invertebrates, McGraw-Hill Education, 7th edition, 2015.
4. Dhami & Dhami, Invertebrate Zoology, R. Chand & Co., India, 2009.
5. Jordan & Verma, Invertebrate Zoology, S. Chand & Co., India, 2013.
6. V.K. Agarwal, Zoology for Degree Students: Non-Chordata, S. Chand & Co., 2017.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks) [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Question: As per Bloom's taxonomy.]

Course Title: Invertebrate Lab.

Part A - Introduction

Course Code: UZOOL102
Course Title: Invertebrate Lab.
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course a student must have had the subject Biology in the 12th class.

Course Learning Outcomes (CLO): Upon completion of the course students should be able to understand

1. Identify invertebrate animals of different phyla and their histology through study of museum specimens and slides.
2. Learn their different systems through dissections.
3. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Part B – Content of the Course

Unit 1: Study of museum specimens and slides relevant to the invertebrates (No. of lectures: 25).

Unit 2: Dissection (Demonstration only – through You Tube video or Models or Charts) (No. of lectures: 25).

a) Earthworm – Digestive system, nervous system, reproductive system.
b) Prawn – nervous system and appendages.
c) Cockroach-Digestive system, nervous system (Easily available animal in residential areas which can be used for dissection and mounting)

Unit 3: Mounting (No. of lectures: 5).

a) Locally available small non-chordates, their larvae.
b) Moth part of insects.

Unit 4: Examination of pond water for study of different kinds of microscopic non-chordate organisms (No. of lectures: 8).

Unit 5: Economic importance of any to insects (No. of lectures: 5).

Unit 6: Parasitic adaptation of any one parasite (No. of lectures: 5).

Keywords/Tags: Museum specimens, Slides, Dissection, Mounting, Benefited isects, Parasitic adaptation.

Part C - Learning resources

Text books:

1. N. Arumuam, N.C. Nair, S. Leelavathy, N.S. Pandian, T. Murugan, Practical Zoology – Invetebrata, Vol.-1, Saras Publication, 2013.
2. P.S. Verma, A Manual of Practical Zoology – Invertebrates, S. Chand & Co., 2013.

Part D - Assessment and Evaluation

A. Internal Assessment: 30 marks [Class Interaction/Quiz: 15 marks; Attendance: 05 marks; Assignments (Charts/Model Seminar/Rural Service/Technology Dissemination/Report of Excursion/Lab. Visits/Industrial Visit): 10 marks.]

B. External Assessments: 70 marks

a) Viva voce on Practical: 10 marks.
b) Practical Record File: 10 marks.

c) Table work/Experiments: 50 marks.
   i. Spotting: 16 marks.
   ii. Dissection: 08 marks.
   iii. Mounting: 04 marks.
   iv. Examination of pond Water: 10 marks.
   v. Economic Importance of Insects: 06 marks.
   vi. Parasitic Adaptation: 06 marks.

Course Title: Cell Biology, Reproductive Biology and Development Biology

Part A - Introduction

Course Code: UZOOL103
Course Title: Cell Biology, Reproductive Biology and Development Biology
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course a student must have had the subject Biology in the 12^{th} class.
Course Learning Outcomes (CLO): Upon completion of the course students should be able to

1. Develop deeper understanding of what life is and how it functions at cellular level.
2. Understand the nature and basic concepts of cell biology, reproductive and developmental biology..
3. Understand structure and functions of cell membrane and cellular organelles.
4. Understand the importance of latest reproductive trends, reproductive techniques to be applied for human welfare.
5. Understand the general patters and sequential development stages during embryogenesis; and understand how the developmental processes lead to establishment of body plans of multi-cellular organisms.
6. Understand about the evolutionary development of various animals.

Part B – Content of the Course

Unit I: Cell Biology (No. of lectures: 13):

1. Concept of Prokaryotic and Eukaryotic Cells, difference between Prokaryotic and Eukaryotic Cells.
2. Structure and functions of Plasma membrane.
3. Structure and functions of Golgi body, Mitochondria, Endoplasmic reticulum, Ribosome and Lysosome.
4. Structure and functions of Nucleus.
5. Structure and functions of Chromosome and special type of chromosomes – Lampbrush and Polytene chromosome.
6. Cell cycle, Mitotic and Meiotic cell division and their significance.

Keywords/Tags: Prokaryote, Eukaryote, Cell organalles, Chromosomes, Cell Cycle.

Unit II: Reproductive Biology (No. of lectures: 13):

1. Structure of male reproductive system of Lepus.
2. Structure of female reproductive system of Lepus.
3. Histology of Testis and Ovary of Lepus.
4. Gametogenesis – Spermatogenesis and oogensis, difference between spermatogenesis and oogenesis.
5. Types of eggs-based on amount and distribution of yolk with examples.

Keywords/Tags: Reproductive system, Gametogenesis, Sperms, Eggs.

Unit III: Recent Assisted Reproductive Techniques (ART) (No. of lectures: 13):

1. Stem cell – types and their uses.
2. Gene bank, sperm bank, superovulation, cryopreservation.
3. In Vitro Fertilization (IVF) and Embryo Transfer (ET), Zygote Intra Fallopian Transfer (ZIFT), Intracytoplasmic Sperm Injection (ICSI).
4. Placement - types, examples, and functions.
5. Placenta Banking – placenta preservation benefits.

Keywords/Tags: Gene bank, Sperm bank, Superovulation, IVF, ET, ZIFT, ICSI, Placenta banking.

Unit IV: Developmental Biology (No. of lectures: 11):

1. Fertilization.
2. Embryonic development of frog up to the formation of three germinal layers.
3. Fate map construction in frog.
4. Metamorphosis of Tadpole Larva.
5. Parthenogenesis.

Keywords/Tags: Fertilization, Frog embryology, Tadpole metamorphosis, Parthenogenesis.

Unit V: Embryonic Development of Chick (No. of lectures: 11):

1. Structure of hen's egg.
2. Embryonic development of chick embryo up to the formation of primitive streak.
3. Fate map construction in chick.
4. Extra embryonic membranes of chick: Formation and functions.

Keywords/Tags: Hen's egg, Chick embryology, fate map, Chick embryo membranes.

Part C- Learning Resources

Text Books:

1. B.I. Balinsky, An Introduction to Embryology, Cengage Learning, 2012.

2. S.R. Bolsover, J.S. Hyams, E.A. Shephard, H.A. White, & C.G. Wiedemann, Cell Biology – A Short Course, Wiley, 2004.
3. T.W. Sadler, Langman's Medical Embryology, 12th edition, Lippincott Williams & Wilkins, 2012.
4. W. Kuehnel, Color Atlas of Cytology, Histology, and Microscopic Anatomy, Thieme, 1992.
5. Verma and Agarwal, A Text Book of Cytology, S. Chand & Co., 1999.
6. Verma and Agarwal, Chordate Embryology, S. Chand & Co., 2000.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks) [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Question: As per Bloom's taxonomy.]

Course Title: Cytology, Reproductive Biology and Embryology Lab.

Part A - Introduction

Course Code: UZOOL104
Course Title: Cytology, Reproductive Biology and Embryology Practical
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course a student must have had the subject Biology in the 12th class.
Course Learning Outcomes (CLO): Upon completion of the course students should be able to understand

1. The different stages of mitotic and meiotic cell division and special types of chromosomes.
2. Different stages of embryology
3. Through squash preparation understand the stages of cell division and structure of polytene chromosomes.
4. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Part B – Content of the Course

Unit 1: Spotting related to the cytology (No. of lectures - 13):

a) Prokaryote and Eukaryote cell
b) Stages of Mitotic cell division.
c) Stages of Meiotic cell division.
d) Lamp brush chromosome.

Unit 2: Spotting related to Reproductive biology and Embryology (No. of lectures - 13):

a) T.S. Testis of Mammal.
b) T.S. Ovary of Mammal.
c) Developmental stages of Frog embryology.
d) Developmental stages of Chick embryology.

Unit 3: Squash preparation of onion root tip to understand the stages of Mitosis (No. of lectures 8).

Unit 4: Squash preparation of grasshopper testis to understand the stages of Mitosis (No. of lectures 9).

Unit 5: Squash preparation of salivary gland chromosome from Chironomus larva/Drosophila (No. of lectures 9).

Keywords/Tags: Stages of cell division, Stage of Embryonic development, Squash preparation.

Part C- Learning Resources

Text Books:

1. M.M. Beffa and J. Knight, Experiments in Practical Development Biology, Cambridge University Press, 2011.
2. K.V. Chaitanya, Cell and Molecular Biology: A Lab. Manual, PHI, 2013.
3. L.R. Keller, J.H. Evans, T.C.S. Keller, Experimental Developmental Biology, Academic Press, 1998.

Part D - Assessment and Evaluation

A. Internal Assessment: 30 marks. [Class Interaction/Quiz: 15 marks.; Attendance: 05 marks; Assignments (Charts/Model Seminar/Rural Service/Technology Dissemination/Report of Excursion/Lab. Visits/Industrial Visit): 10 marks.]

B. External Assessments: 70 marks [Viva voce on Practical: 10 marks; Practical Record File: 10 marks; Table work/Experiments: 50 marks.]

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Subject: Botany

Course Title: Applied Botany

Part A – Introduction

Course Code: UBOTA101
Course Title: Applied Botany
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Biology/Life Sciences/Agriculture in class 12^{th}.
Course Learning Outcomes (CLO): By the end of this course the student should have:

1. Understood the significance and role of botany.
2. Learnt the basic aspects of applied botany.
3. Gained knowledge about employment opportunities in field of botany.
4. Learnt about opportunities of social services.
5. Gained knowledge about best health practices.

Part B – Content of the Course

Unit I: (No. of lectures: 12):

1. Introduction, objectives, and importance of applied botany.
2. History and evolution of botany.
3. Relation of plants to man and relation with other services.
4. Various disciplines of botany and their applications to human welfare.

Unit II: (No. of lectures: 12):

1. Definition and types of pollution and pollutants.
2. Phytoremediation: Air, water, soil, noise, and thermal pollutants (any plants with botanical name, family) and their role in pollution control.
3. Bioremediation: Definition and types.

Unit III: (No. of lectures: 12):

1. Ancient agricultural practices.
2. Modern agriculture practices: Polyhouse, drip irrigation, hydroponics, computer based agriculture, terrace farming.
3. Organic farming: Introduction, objective and brief technique.
4. Horticulture: Definition and role in human welfare.
5. Forestry: Definition, branches, and role in human welfare.
6. Silviculture: Definition and management practices.

Unit IV: (No. of lectures: 12):

1. Role of botany in rural development.
2. Ethnobotany: Introduction and importance.
3. Ethnomedicine: Definition and examples (local name, botanical name, family and importance of NeemAloe, Clove, Ginger, Tulsi, Turmeric, Giloy, Emblica, Ashwagandha, Arandi).
4. Ethno-fibres: Definition and examples (local name, botanical name, family and importance of Ankara, Coconut, elephant, grass, cotton).
5. Ethno-food crops: Definition and examples (local name, botanical name, family and importance of Garadu, Singada, Kutaki, Sama, Kodo, Bathua, Sehjan, Jowar, Makka, Bajra, Jau).

Unit V: (No. of lectures: 12):

1. Plant tissue culture: Definition, types and importance.
2. DNA recombinant technique: Introduction, tools and importance.
3. Role of recombination in present era.
4. Bioinformatics: Definition, concept and tools.
5. Introduction to bioinformatics software: Basic idea of BLAST and FASTA, importance of bioinformatics.

Keywords/Tags: Applied botany, history of botany, Evolution of botany, Botany in human welfare, Pollution, Pollutants, Phytoremediation, Bioremediation, hydroponics, Polyhouse, Terrace farming, Organic farming, Horticulture, Silviculture, Ethnobotany, Ethnomedicine, Ethno-fibres, Ethno-food crops, Bioinformatics, BLAST, FASTA, Recombinant DNA, Plant tissue culture.

Part C- Learning Resources

Text books:

1. E. Levetin and K. Mcmahon, Plants & Society, McGraw Hill Education, 2007.
2. R. Maiti, H.G. Rodriguez, & A.S. Thakur, Applied Botany, American Academic Press, 2017.
3. R.P. Agrahari, Environmental Ecology, Biodiversity, Climate Change, & Disaster Management, McGraw Hill Education, 2020.
4. Jin Xiong, Essential Bioinformatics, Cambridge University Press, 2006.
5. Kevin J. Gaston & John I. Spicer, Biodiversity – an introduction, Blackwell, 2004.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks) [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Question: As per Bloom's taxonomy.]

Course Title: Applied Botany Lab.

Part A – Introduction

Course Code: UBOTA102
Course Title: Applied Botany Lab.
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Credits: 2 credits.
Total Marks: 30 + 70, Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject botany in class 12^{th}.
Course Learning Outcomes (CLO): By the end of this course, the student should have knowledge of practical skill related with ethnobotany, tissue culture, application of bioinformatics software, and tool of recombinant DNA technology.

Part B – Content of the Course

1. Identification of ethnobotanical plants.
2. Preparation of soil health card of any agricultural field.
3. Study of vermicompost and composting of kitchen waste.
4. Use of BLAST & FASTA.
5. Prepare the list of important air, water, & soil pollutants of local areas.
6. Plant tissue culture technique: Sterilization, inoculation, culture media, acclimatization, & hardening.
7. Preparation of list of ethnomedicinal, food, fibre plant locally available.
8. Tools of recombinant DNA technology: Restriction, enzymes, plasmid vectors, other enzymes.
9. Study of global warming, acid rain, & water.

Part C – Learning Resources

Text books:

1. E. Levetin & K. Memahon, Plants & Society, Mc Graw Hill Education, 2007.
2. R. Maiti, H.G. Rodriguez, & A.S. Thakur, Applied Botany, American Academic Press, 2017.
3. R.P. Agrahari, Environmental Ecology, Biodiversity, Climate Change & Disaster Management, Mc Graw Hill Education, 2020.
4. D.K. Sharma, Biodiversity Conservation: Current Status & Future Strategies, Write & Print Publication, 2017.
5. J. Singh, Biodiversity Environment & Sustainability, M.D. Publications Pvt. Ltd., 2008.
6. P.K. Gupta, Molecular Biology & Genetic Engineering, Rastogi Publications, 2005.

Part D – Assessment and Evaluation

A. Internal Assessment: 30 marks. [Class Interaction/Quiz: 15 marks; Attendance: 5 marks, Assignments (Charts/Model seminar/Rural service/Technology dissemination/Report of excursion/Lab. visit/Survey/Industrial visit): 10 marks]

B. External Assessment: 70 marks. [Viva voce on Practical: 10 marks; Practical Record File: 10 marks, Table work/Experiment: 50 marks.]

Course Title: Basic Botany

Part A – Introduction

Course Code: UBOTA103
Course Title: Basic Botany
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject botany in class 12^{th}.
Course Learning Outcomes (CLO):

1. The course will help the student to understand the diversity of plants and evolutionary process in plant kingdoms.
2. It gives an account of plant adaptation from aquatic condition to colonize terrestrial habitat.
3. The changes in morphological, anatomical and reproductive structures that propel plant evolution can be investigated.
4. The economic importance and significance of plants in nature will be understood.
5. They will be acquainted with locally prevalent microbial disease of plants and humans.

Part B – Content of the Course

Unit I: (No. of lectures: 12):

1. History of botany and Indian contributions.
2. Morphological characteristics of lower and higher plants (Angiosperms).
3. Types of leaves, inflorescence, flowers, and fruits.
4. Structure of plant cell and cell organelles, prokaryotic and eukaryotic cells, types of cell division.
5. Microscope structure and function of light microscope (magnification and resolving power)
6. Various types of microscopes: Bright field, phase contrast, SEM & TEM

Unit II: (No. of lectures: 12):

1. Algae
   1.1. General characteristics.
   1.2. Range of thallus organization, reproduction.
   1.3. Types of life-cycles in algae.
   1.4. Role of algae in nature and its economic importance.
2. Bryophytes
   2.1. General characteristics, ecology.

2.2. Range of thallus organization, morphology, anatomy (internal and external features), & reproduction of any one Bryophyte.
2.3. Economic importance of Bryophytes.

Unit III: (No. of lectures: 12):

1. Pteridophytes
   1.1. General characteristics and morphology.
   1.2. Stelar organization and reproduction.
   1.3. Heterospory and seed habit.
   1.4. Economical importance
2. Gymnosperms
   2.1. General description and their distribution
   2.2. Economical importance of gymnosperms.
3. Paleonotany
   3.1. Indian contribution to paleobotany.
   3.2. Brief knowledge of fossils and geological time scale.

Unit IV: (No. of lectures: 12):

1. Fungi
   1.1.General characteristics and cell wall compostion.
   1.2.Mode of nutrition.
   1.3.Types of reproduction.
   1.4.Economic importance.
   1.5. Parasexuality and Mycorrhiza.
2. Lichens: Brief knowledge and their significance.

Unit V: Microbes (No. of lectures: 12)

1. Brief outline of various types of microbes.
2. Archaebacteria, Eubacteria, Cyanobacteria, Mycoplasma, Actinomycetes, & Virus.
3. Beneficial & harmful roles.

Keywords/Tags: History of botany, Palebotany, Prokaryotes, Eukaryotes, Algae, Bryophyta, Pteridophyta, Gymnosperms, Fungi, Mycorrhiza, Lichens, Bacteria, Virus.

Part C – Learning Resources

Text books:

1. O. Oladele, Microbial Diversity: Form & Function in Prokaryotes, Wiley Blackwell, 2008.
2. L. Presscort, J. Harley, & D. Klein, Microbiology, Tata McGraw-Hill Co., New Delhi, 2005.
3. P.C. Vasishtha, Botany for Degree students: Gymnosperms, revised edition, S. Chand & Comp. Ltd., New Delhi, 2018.
4. O.P. Sharma & Shivani Dixit, Gymnosperms, Pragati Prakashan, Meerut, 2015.
5. M.J. Pelezar et al., Microbiology, Tata McGraw-Hill Co., New Delhi, 2001.
6. S.P. Bhatnagar & Alok Moitra, Gymnosperms, New Age International (P.) Ltd., New Delhi, 2000.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks [Class test: 20 marks, Assignment/presentation: 10 marks.]
B. External Assessment/University Exam: 70 marks. Time: 3 hours. Question pattern: Bloom's taxonomy.

Course Title: Basic Botany Lab.

Part A – Introduction

Course Code: UBOTA104
Course Title: Basic Botany Lab.
Pre-requisite (if any): To study this course, a student must have had the subject botany in class 12th.
Course Learning Outcomes (CLO):
1. Students will learn to carry out practical work in the laboratory.
2. Interpreting plant morphology & anatomy of various groups of lower & higher plants.
3. Students will be able to identify the major groups of microorganisms.

Credits: 2 credits.
Total Marks: 30 + 70 = 100, Min. Passing Marks: 35

Part B – Content of the Course

1. Study of various types of leaves, inflorescence, flowers & fruits.
2. Understanding various parts of Microscope (simple & compound microscope).
3. Study of plant cells (e.g., onion etc.).
4. Study of Electron Micrographs of Cell and organelles from internt, youtube.
5. Identification of various algae from speciments, slides & temporary mounts of water from nearby areas like *Nostoc*, *Oscillatoria*, *Volvox*, *Spirogyra*, *Oedogonium*, *Chara*, and specimens and pictographs of marine algae like *Ectocarpus*, *Sargasssum*, *Polysiphonia*.
6. Study & identification of some Bryophytes like *Riccia*, *Marchantia*, *Anthoceros*, *Funaria* & field visit.
7. Study of some fossils (specimens & slides).
8. Study of some Pteridophytes like *Lycopodium*. *Sellaginella, Equisetum* and *Marselia*.
9. Section cutting of Pteridophytes & Gymnosperms: Stem, root, & leaves.
10. Specimen study of Pteridophytes & Gymnosperms cones.
11. Study of fugal structures & preparation of temporary mounts of *Mucor, Rhizopus, Asperigillus, Yeast, Pencillium, Alternaria, Albugo, Helimenthosporium*.
12. Permanent slides of Puccinia on host.

13. Study of various fungal plant diseases.
14. Observation of symptoms of virus & bacteria on plant.
15. Gram staining techniques.

Key works/Tags: Microscope, Algae, Bryophyta, Pteridophyta, Gymnosperms, Fungi.

Part C – Learning Resources

Text books:

1. A. Bendre & A. Kumar, A Textbook of Practical Botany, Vol. I, Rastogi Pub., Meerut, 1984.
2. B.P. Pandey, Modern Practical Botany, Vol. 1, S. Chands & Co. Ltd., N. Delhi, 1999.
3. M.P. Singh, S.B. Chaudhary, & H. Sahu, Textbook of Practical Botany, Daya Pub. House, N. Delhi, 2005.
4. E. Margaret & G. Angela, Practical Manual of Botany, Vol. 1, New Age, 2007.

Part D – Assessment and Evaluation

A. Internal Assessment: 30 marks [Class Interaction/Quiz: 15 marks; Attendance: 5 marks; Assignments (Charts/Model seminar/Rural service/Technology dissemination/Report of excursion/Lab. visit/Survey/Industrial visit): 10 marks]

B. External Assessment: 70 marks [Viva voce on Practical: 10 marks; Practical Record File: 10 marks, Table work/Experiment: 50 marks.]

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Subject: Biotechnology

Course Title: Cell Biology and Biotechnology

Part A - Introduction

Course Code: UBIOT101
Course Title: Cell Biology and Biotechnology
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Biology in 12th class.
Course Learning Outcomes (CLO): The main objective of the course will be to build the basic foundation for studying biotechnology. The Demand for trained work force in biotechnology is ever-growing in fundamental research and industry sector. Academic and research sectors also require interdisciplinary trained manpower to foster the biotechnology revolution. The restructured syllabus combines basic principles of chemical and biological sciences in light of advancements in technology .T he curriculum aims to impart basic knowledge with emphasis on its applications to make the students ready for industries and research work in concerned field .At the end of the paper student should be able to –

1. Understand basics of cell biology.
2. Appreciate the importance of bonding and spatial arrangement of molecules for proper functioning and stability.
3. Understand both the physical as well as chemical properties of biomolecules.
4. The student could pursue a career in biochemical testing .The decrease of increase in the amount of some of the biomolecules can have clinical significance .
5. Students can also go in for medical laboratory technique courses, opening opportunities in hospital and pathological laboratories.

Part B – Content of the Course

Unit I: Cell as a Basic Unit (No. of Lectures: 12):
1. Historical background of the Cell
1.1 History of Cell Biology.
1.2 Cell Structure.
1.3 Cell Theory.
2. Prokaryotic Cell and Cell Organells:
2.1 Ultrastructure of Prokaryotic Cell.
2.2. Structure and function of cell organelles:Flagella, Pili. Cell wall,Cytoplasmic membrane, Nuclear region, Ribosomes, Vacuoles, Metachromatic granules, Spores and Cysts, Microtubules, Microfilaments, Centriole.
2.3 Difference between Prokaryotic and Eukaryotic cells.

Key Words: - Cell theory, Prokaryotic Cell

Unit II: Cell Organelles and Cell Cycle (No. of Lectures: 12):

1. Eukaryotic Cell and Cell Organells:
1.1 Ultrastructure of Eukaryotic cell (Plant and Animal cells).
1.2 Structure and function of cell organelles: Cell membrane, Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi bodies, Lysosomes, Peroxisomes, Nucleus.
2. Cell Cycle:
2.1 Cell cycle and Cell division.
2.2 Apoptosis or Cell death.

Keywords: Eukaryotic cell. Cell organelles, Cell cycle. Apoptosis

Unit III: Molecular Structure of Water (No. of Lectures: 12):
1. Water structure and Buffer:
1.1 Properties of Water.
1.2 Interaction of Water.
1.3 Role of Water in Bio molecular Structure.
1.4 Acid and Bases, Buffer solutions.
2. Chemical Bonds:
2.1 Chemical Bonds (Ionic Bond, Covalent Bond, Coordinate Bond, Non Covalent Bonds, Hydrogen Bond)

Keywords: Water, Buffer, Chemical bonds.

Unit IV: Biomolecules:(No. of Lectures: 12)
Sources. Nomenclature, Classification, Structures, Characteristics and Functions:
1. Carbohydrates,
2. Lipids.
3. Proteins and Nucleic Acids.

Keywords: - Carbohydrates, Proteins, Lipids, Nucleic Acids.

Unit V: Tools and Techniques: (No. of Lectures: 12)
1.1 Principle and Applications of Light Microscopy, Centrifugation, Chromatography (Paper, Thin layer and Column), Colorimeter and Spectrophotometer.

Keywords: - Microscope, Chromatography, Spectrophotometer.

Part C - Learning Resources

Text books:
1. Industrial Biotechnology-B.D. Singh
2. Textbook of Biochemistry - S.P. Singh
3. Cell and Molecular Biology-P.K. Gupta
4. Cell Biology-P.S. Verma and Agrawal
5. Cell and Molecular Biology - S.C.Rastogy
6. Cell Biology - P.S. Verma and Agrawal

Part D – Assessment and Evaluation

A. Internal evaluation/Continuous Comprehensive Evaluation (CCE): 30 marks [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External/University Exam (UE): 70 marks [Time: 3 hours]

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Course Title: Cell Biology and Biotechnology Lab.

Part A - Introduction

Course Code: BIOT102
Course Title: Cell Biology and Biochemistry Lab.
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Biology in 12^{th} class
Course Learning Outcomes (CLO): The Main Objective of the course will be to give hands-on practical knowledge in Biotechnology. The Demand for Trained work force in Biotechnology is ever growing in Fundamental Research and Industry Sector. Academic and Research Sectors Require Interdisciplinary trained manpower to foster the Biotechnology Revolution. The curriculum aims to impart basic knowledge with emphasis on its applications to make the students ready for industries and research work in concerned field. At the end of the paper, a student will be able to:
1. Understand basic techniques of cell biology.
2. Know the physical as well as chemical properties of biomolecules.
3. Pursue a career in biochemical testing. The decrease of increase in the amount of some of the biomolecules can have clinical significance.
4. Take medical Laboratory Technique Courses, opening opportunities inhospitals and pathological laboratories.

Part B – Content of the Course [Total number of practical (in hours) - 30]:

List of experiments -

1. To study the plant cell structure using various plant materials.
2. To study the animal cell structure using cheek cells.
3. To Prepare Onion root tip for the stages of Mitosis.
4. To Prepare and study the different stages of Mitosis and Meiosis.
5. To analyze Carbohydrates Quantitatively.
6. To analyze proteins Quantitatively .
7. To analyze lipids Quantitatively .
8. To Prepare Buffers.
9. To Separate plant pigments by Paper Chromatography.
10. To Separate amino acids by TLC.

Part D – Assessment and Evaluation

A. Internal Assessment: 30 marks [Class Interaction/Quiz: 15 marks; Attendance: 5 marks; Assignments (Charts/Model seminar/Rural service/Technology dissemination/Report of excursion/Lab. visit/Survey/Industrial visit): 10 marks]

B. External Assessment: 70 marks [Viva voce on Practical: 10 marks; Practical Record File: 10 marks, Table work/Experiment: 50 marks.]

Course Title: Microbiology and Immunology

Part A - Introduction

Course Code: UMICB101

Course Title: Microbiology and Immunology

Credit value: 4

Total Marks: 30 + 70 = 100; Min. Passing Marks: 35

Pre-requisite (if any): To study this course, a student must have had the subject Biology in 12^{th} class

Course Learning Outcomes (CLO): To create general understanding about microbiology and immunology.

1. The students will be able to understand microbial diversity and Nutrition.
2. The students will be able to understand immune system. Immune responses and Vaccination.
3. The students will be able to describe role of immune system in both maintaining health and contributing to disease.
4. The students will be able to understand immunological techniques.

At the end of the course student will familiar with -

1. Microbial diversity and nutrition.
2. Immune system, its properties and types.
3. Immunoglobulin structure, types and functions and can apply the concept of hypersensitivity and vaccination for different diseases.
4. Perform various immunological techniques.

Part B – Content of the Course

Total lectures – 60 hours

Unit I: History, Basic concepts of Microbiology and Culture Media preparation (No. of lectures: 12):

1. History, Basic concepts of Microbiology:

1.1 Fundamental, History and evolution of microbiology. Development of microbiology, Application of microbiology in human welfare.

1.2 Classification, General characteristic and structure of Bacteria. Fungi and Viruses.

2. Media Preparation:

2.1 Methods and Types Culture, Minimal, Selective, differential, Transport media.

2.2 Synchronous, Batch and Continuous culture.

Keywords: Classification of Microorganisms. Media Preparation.

Unit II: Microbial Growth and Growth measurement: (No. of lectures: 14):

1. Microbial Growth:

1.1. Definition of growth, Mathematical expression of growth, Growth Curve, Generation time, Growth yield. Effect of nutrients on growth.

1.2. Factor affecting growth: Nutrient, Temperature, Oxygen, pH, Osmotic pressure.

2. Growth measurement:

2.1 Measurement of Growth (Direct and Indirect methods): cell number, Cell Mass and Cell Activity.

2.2. Cell Count: Turbidometric method, Plate count method. Membrane count method, Dry weight and Wet method by measurement of cellular activity.

Keywords/Tags: Growth. Measurement.

Unit III: Basics of Immunology (No. of lectures: 10):

1. Basics of Immunology:

1.1. Concept of Innate and Acquired immunity, Phygocytosis complement and inflammatory responses.

1.2. Immune cells and organs: Structure, Function and Properties of immune cells -Stem cell. T-cell, B-cell. NK-cell . Macrophagus, Neutrophil, Eosinophil , Basophil, Mast cell, dentric cell.

1.3 Immune organ: Bone marrow, Thymus, Lymph Node, Spleen, Lymphatic system.

Keywords/Tags: Immunity, Immune cells.

Unit IV: Immunoglobulins and Immune response (No. of lectures: 15):

1. Immunoglobulins

1.1. Antigens: Characteristics of an antigen: Foreignness, Molecular size, Chemical composition and Heterogeneity. Antigen Adjuvants, Epitopes, Haptens.

1.2. Antibodies: Structure, Types, Functions and Properties of antibodies Antigenic determinant on antibodies (Isotypic, Allotypic, Idiotypic). Monoclonal, Polyclonal and Chimeric antibody.

2. Immune response:

2.1. Generation of immune response: Primary and Secondary immune response, generation of Humoral response (Plasma and Generation of cell mediated immune response (self MHC Memory cell), restriction, T-cell activation, Co-stimulatory signals), Killing Mechanisms by CTL and NK cells, Introduction to tolerance.

Keywords/Tags: Antigens, Antibody.

Unit V: Microbial, Immunological Techniques and Vaccination (No. of lectures: 10):

1. Microbial Techniques:

1.1. Principle, Working and applications of instruments -Laminar airflow, Autoclave, Hot air oven.

2. Immunological techniques:

2.1. RIA, ELISA, Western blotting. Principles of Precipitation, Agglutination, Immunodiffsion, Immuno electophorosis.

3. Vaccination:

3.1. Vaccines and vaccination: Rubella, Varicella(Chickenpox), Polio, Diptheria, Hepatitis vaccine.

Key Worlds: RIA, ELISA, Laminar air flow, Autoclave, Vaccine.

Part C Learning Resources

Text Books:

1. Fundamentals of microbiology and immunology; A.K.Banerjee and Nirmalaya Banerjee, New Central Book Agency, New Delhi
2. Modern concepts of microbiology: H.D. Kumar and Swati Kumar., Vikas Publishing House Pvt Ltd., 2nd Edition.
3. Microbiology: M.J. Pelczar, E.C.S. Chan and N.R.Krieg, McGraw Hill Book company.1993, 5th edition
4. A text book of microbiology: R.C.Dubey and D.K.Maheshwari . S Chand and Company Ltd 2004, 1" edition.
5. Microbiology; P.D.Sharma, Rastogi Publication, Meerut.
6. General Microbiology Vol I and II; C.B. Powar and H.F.Dagniwala.
Himalaya Publication.
7. Microbiology Fundamental and Applications: S.S.Purohit, Agrobias, 7th Edition.
8. Immunology :K.R. Joshi, Agrobios. 5th edition.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks) [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours; Question: as per Bloom's taxonomy]

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Course Title: Microbiology and Immunology Lab.

Part A - Introduction

Course Code: UMICB102
Course Title: Microbiology and Immunology Lab.
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have had the subject Biology in 12^{th} class
Course Learning Outcomes (CLO): The objective of the course is to prepare students competent in subject through in-depth lecture and laboratory practices-

1. The students will be able to identify microbes using modern techniques.
2. The students will acquire skill and competence in microbiological and immunological laboratory practices applicable to microbiological research or clinical methods of immunology, including accurately reporting observations and analysis. On completion of this course, learners will be able to have sufficient scientific understanding of microbiology and immunology-

1. Students apply concept, Principle and types of sterilization methods viz performing microbiological experiments.
2. Students apply the concept and characteristics of antiseptic, disinfected and their mode of action in day to day life.
3. Students will apply principle, working and applications of instruments -Laminar airflow, Autoclave, Hot air oven etc.

Part B – Content of the Course [Total number of practical (in hours) - 30]:

List of experiments:

1. To perform Aseptic technique, Cleaning of glassware's, preparation of Cotton Plugging and Sterilization.
2. To prepare Bacterial and Fungal media.
3. To isolate microbes from Air, Water and Soil.
4. To Study dilution and plating by Pour Plate, Spread Plate methods.
5. To Study microorganisms by Staining method - Simple staining, Gram staining, Endospore staining, Fungal staining. Negative staining.
6. To identify bacteria based on staining, Shape and Size.
7. To enumerate microorganism - Total and Viable count.
8. To study Antibiotic sensitivity of microbes by the use of antibiotic discs.
9. To isolate and identify pathogenic bacteria from sewage and waste water.
10. To Determine growth curve and generation time of E. coli.
11. To identify of human blood groups.
12. To enumerate total WBC of the given blood sample by hemocytometer.
13. To enumerate differential Leukocyte of the given blood sample.
14. To enumerate total RBC of the given blood sample by hemocytometer.
15.To isolate and Identify aquatic Fungi from Local water body.

Part C Learning Resources

Text Books: Suggested Readings

1. Laboratory Techniques in Modem Biology: N.Swarup, S.C. Pathak, & S. Arora, Kalyanim Publication, New Delhi.
2. Integrated Methodologies in Biology :Shashi Shrivatava Banerjee, Arun Prakashan, Gwalior.
3.Experiment in Microbiology Plant Pathology and Biotechnology : K.R.Anejan, New Age International New Delhi, 2007.
4. Laboratory Manual of Biotechnology: P.N. Swamy, Rastogi Publication Meerut.
5. Practical Microbiology: R.C. Dubey, D.K. Maheshwari, S Chand & Company, Delhi.
6. Manual of Experiments in Biotechnology: Leena Lakhani, Sheeba Khan. Kailash Pustak Sadan, Bhopal.

Part D – Assessment and Evaluation

A. Internal Assessment: 30 marks [Class Interaction/Quiz: 15 marks; Attendance: 5 marks; Assignments (Charts/Model seminar/Rural service/Technology dissemination/Report of excursion/Lab. visit/Survey/Industrial visit): 10 marks]

B. External Assessment: 70 marks [Viva voce on Practical: 10 marks; Practical Record File: 10 marks, Table work/Experiment: 50 marks.]

Course Title: General Introduction to Bioinformatics

Part A - Introduction

Course Code: UBIOI101
Course Title: General Introduction to Bioinformatics
Credit value: 4
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have Biology and/or Mathematics as one of the subjects in class 12^{th}
Course Learning Outcomes (CLO): The students shall be able to:
1. Get the general overview of internet protocols and general introduction of bioinformatics.
2. Acquire the knowledge about the biological databases, sequence alignments, data retrieval system, phylogenetic analysis and comparative genome analysis.
3. Join as lab assistant/ technical assistant in any R&D project in Life sciences.

Part B – Content of the Course

Unit I: Introduction to Bioinformatics (No. of lectures: 15):
1.1 Introduction to Bioinformatics and application oriented background of bioinformatics.
1.2 Introduction to Biological Databases.
1.3 Types of Biological Databases: Nucleic Acid Databases, Protein Databases, Specialized Genome Databases, Structure Classification Databases and Structure Database.

Keywords: Biological Databases, Nucleic Acid Database, Protein Databases, Specialised Genome Database, Structure Classification Database, Structure Databases.

Unit II: Data Acquisition and Information Retrieval from Biological Databases (No. of lectures: 15):
2.1 Data Acquisition - concept and purposes.
2.2 Information Retrieval from Biological Databases: Integrated information Retrieval (Entrez System), Retrieving database entries.
2.3 The NCBI data model: Introduction, Seq-id, Sequence, collection of sequence, annotation of sequence, describing sequence.
2.4 GenBank Sequence Database: Introduction to structure, Primary and secondary database, Format vs Content: Computer vs. Human, Databases, Genbank Flat file, GCG.

Keywords/Tags: Entrez, NCBI, Sequence, Seq-id, GenBank

Unit III: Sequence Alignment and Database Searching (No. of lectures: 15):
3.1 Sequence Alignment And Database Searching: Introduction, Evolutionary Basis of Sequence Alignment
3.2 Optimal alignment method, Substitution Score and Gap Penalty, Statistical Significance of Alignment. Database similarity searching, FASTA, BLAST, Database searching Artefacts, Position Specific Scoring Matrices.

3.3 Multiple Sequence Alignment (MSA): About MSA, Structural or Evolutionary Alignment, ways to align Sequences, Tools.

Keywords/Tags: Sequence Alignment, FASTA, BLAST, Optimal alignment method.

Unit IV: Phylogenetic Analysis, Predictive Methods and Comparative Genome Analysis (No. of lectures: 15):
4.1 Phylogenetic Analysis: Fundamental of Phylogenetic model, Tree interpretation - Paralogues and orthologues, Tree building and Tree evaluation, Phylogenetic software.
4.2 Predictive Method using Nucleotide Sequence: Introduction, Marking repetitive DNA, Database search, Codon bias detection, detecting functional site in DNA.
4.3 Predictive Method using Protein Sequence: Protein identification based on composition, Physical properties based on sequence, Motif and pattern, Secondary structure and folding classes, specialized structure or features, Tertiary structures.
4.4 Structure Database: Introduction to Structure, PDB, MMDB, Structure file format, visualizing structure information, Structure viewers, structure similarity searching. Advanced structure modelling.
4.5 Comparative Genome Analysis: Introduction. application, genome analysis and annotation.

Keywords: Phylogenetic Analysis, Predictive Method, Motif, PDB, MMDB, Comparative Genome Analysis.

Part C Learning Resources

Text Books:
1. Bioinformatics, Andreas D. Baxevanis, David S. Wishart, Gary D. Bade, Wiley, United Kingdom, 2019.
2. Essential Bioinformatics, Xiong, Jin, Cambridge University Press, United States, 2014
3. Bioinformatics: Sequence and Genome Analysis, Mount, D. W., CBS Publishers & Distributors, India, 2005.
4. Introduction to Bioinformatics, Lesk, Arthur M, Oxford University Press, USA, 2019. 5th edition
5. Bioinformatics: methods and applications: (Genomics, Proteomics and Drug Discovery), Mendiratta, N., Rastogi, P., Rastogi, S. C., PHI Learning, India, (2013).
6. Bioinformatics: Principles and applications, Ghosh, Z., Mallik, B., Oxford Press, New Delhi, India, 2012.
7. Bioinformatics and Functional Genomics, Jonathan Pevsner, Wiley. United Kingdom, 2015. 3rd edition.

Part D – Assessment and Evaluation

A. Internal Assessment/Continuous Comprehensive Evaluation (CCE): 30 marks) [Class Test – 20 marks; Assignment/Presentation – 10 marks.]
B. External Assessment/University Exam (UE): 70 marks [Time: 03.00 hours]

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Course Title: General Introduction to Bioinformatics Lab.

Part A - Introduction

Course Code: UBIOI102
Course Title: General Introduction to Bioinformatics Lab.
Credit value: 2
Total Marks: 30 + 70 = 100; Min. Passing Marks: 35
Pre-requisite (if any): To study this course, a student must have Biology and/or Mathematics as one of the subjects in class 12^{th}
Course Learning Outcomes (CLO): The students shall be able to:
1. Retrieve the DNA/Protein sequences from databases and analyze them using bioinformatics tools.
2. Perform multiple sequence alignment using bioinformatics tools.
3. Visualize the structures of proteins.

Part B – Content of the Course [Total number of practical (in hours) - 30]:

List of experiments -
1. Introduction to NCBI.
2. Using Entrez to search Literature Databases.
3. Retrieving DNA sequence from GenBank and analyzing various formats of the data stored.
4. Retrieving Protein sequence from GenPept (NCBI) and Expasy.
5. Analyzing Protein Sequences.
6. Analyzing DNA sequence.
7. Sequence alignment using BLAST (Basic Local Alignment Search Tool).
8. Sequence alignment using FASTA.
9. Multiple sequence alignment using ClustalW.
10. Introduction to the structure database PDB.
11. Visualization of the protein structure using VMD.
12. Secondary structure prediction using GOR algorithm.

Part C Learning Resources

Text Books, Reference Books

1. Bioinformatics, Andreas D. Baxevanis, David S. Wishart, Gary D. Bade, Wiley, United Kingdom, 2019.
2. Essential Bioinformatics, Xiong. Jin, Cambridge University Press, United States, 2014.
3. Bioinformatics: Sequence and Genome Analysis, Mount, D. W., CBS Publishers & Distributors, India, 2005.
4. Introduction to Bioinformatics, Lesk, Arthur M. Oxford University Press, USA, 2019. 5th edition
5. Bioinformatics: methods and applications: (Genomics, Proteomics and Drug Discovery), Mendiratta, N., Rastogi, P., Rastogi, S. C., PHI Learning, India, 2013.
6. Bioinformatics: Principles and applications, Ghosh, Z., Mallik, B., Oxford Press, New Delhi, India, 2012.
7. Bioinformatics and Functional Genomics, Pevsner, Jonathan, Wiley, United Kingdom, 2015. 3rd edition.

Part D – Assessment and Evaluation

A. Internal Assessment: 30 marks [Class Interaction/Quiz: 15 marks; Attendance: 5 marks; Assignments (Charts/Model seminar/Rural service/Technology dissemination/Report of excursion/Lab. visit/Survey/Industrial visit): 10 marks]

B. External Assessment: 70 marks [Viva voce on Practical: 10 marks; Practical Record File: 10 marks, Table work/Experiment: 50 marks.]

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